Journal of the Society of Arts.

FRIDAY, JUNE 6, 1856.

ANNUAL CONFERENCE AND DINNER.

The Annual Conference of the Representatives from Institutions in Union with the Society is appointed to be held at the Society's house, on Monday, the 23rd of June.

The Annual Dinner will take place at the Crystal Palace, on Tuesday, the 24th of June. The Right Honourable Lord Ashburton, F.R.S., will preside.

TWENTY-FIFTH ORDINARY MEETING.

Wednesday, June 4, 1856.

The Twenty-fifth Ordinary Meeting of the One Hundred and Second Session was held on Wednesday, the 4th inst., Joseph Glynn, Esq., F.R.S., in the Chair.

The following Candidates were balloted for, and duly elected Ordinary Members :—

Hogg, Alexander.	Tussaud, Francis Babington.

The paper read was—

THE MANUFACTURE OF BRICKS BY MACHINERY.

By Humphrey Chamberlain, Draining Engineer, Kempsey, near Worcester.

The manufacture of bricks is a subject embracing so great a diversity of treatment, from local circumstances, the varying chemical quality of the earths or clays, and the great number of improvements lately introduced, as well as from the multifarious processes under which the manufacture is carried on, that I am obliged to abandon describing the principle best suited to each particular class of earth, and merely to give a general idea of the manufacture and the mechanical contrivances invented for its improvement, nor will the limits of this paper allow of more.

The process of brickmaking is one of the most ancient manufactures in the world. We are told in Scripture that the tower of Babel was built with well-burnt bricks; that the walls of Babylon were of a similar construction; and that the Israelites, during their oppression by the Egyptians, were employed in brickmaking. The ancient Romans were brick and tile makers; excellent specimens of their manufacture still remain. In England, bricks were not generally used until the middle of the 15th century. The Lollard's Tower, Lambeth Palace, built in 1454, is about the most ancient brickwork in London. The old part of Hampton Court was built in 1514.

I have given this glance at the antiquity of the process to show that, although so ancient, it has received scarcely any improvement from the aid of machinery until within the last few years.

At the present time bricks are manufactured in the most primitive way. Those made by hand are generally of very inferior quality to machine-made ones. The numerous titles of the London bricks best illustrate the state of this manufacture. There are wash bricks, grey stocks, rough stocks, paviours, pickings, grizzles, place, shuffs, and numerous other titles. Now, there should be but one quality, if the process was carried out with good machinery in a suitable manufactory, and those all best bricks. A very few experiments will prove a clay, as to what preparation or mixture of other earths it requires, and the temperature at which it burns to the best colour and soundest article. From the London makers so strictly adhering to the old system of handmaking and clamp burning, they have opened a market for makers by machinery over the country, who, from the superiority of their ware, command such a price, that they can now afford to send bricks by railway, 80 and 100 miles, to the metropolis.

One great check to improvement, both here and at Manchester, is the existence of clubs amongst the men, but these must give way as other districts advance.

The importance of the brick trade is illustrated by the following:—

The quantity of bricks made per annum in this kingdom is about 1,800,000,000. Of this quantity Manchester alone makes about 130,000,000 per annum. What are termed the London makers produce about the same quantity, but bricks are sent to the metropolis from a circuit of 100 miles; it is, therefore, impossible to give exactly the consumption. Taking bricks at the low average of three tons per 1,000, the annual make exceeds in weight 5,400,000 tons, and the capital employed must be upwards of £2,000,000 sterling.

Before entering on the manufacture by machinery, I will briefly describe the present process of making by hand, as practised in the neighbourhood of London.

The clay is dug in the winter, and spread over a large surface of ground, to expose it as much as possible to weather, more particularly frost, to act on the compact tough mass, and so divide it into as small particles as possible, that during the summer, or making season, labour may be saved in working in that quantity of water which is necessary to bring it into a ductile mass. This clay is thrown out in layers, over which are spread coal ashes, or what is termed breeze, which perform several functions. First, they make the clay of a more porous and open character, which is attained by using sand in the country; secondly, they prevent the clay shrinking too much, and the sun and the wind cracking the bricks when drying; and thirdly, they are useful in the firing of the ware, by assisting to burn the bricks. Chalk is also added, for the sake of colour, and acts as a flux on the silica of the clay in burning. This is tempered by hand into an even mass of soft clay or mud, which is effected by turning it over several times with wooden spades, and at each turn working in as much water as possible. This operation is not considered complete until all the clay has absorbed an equal quantity of water, and become a thick plastic mud; to effect this pug-mills are also used, and chalk mills, but the latter is more for the sake of colour, and is only a local practice. This clay is made into bricks by an artisan called the moulder, who is supplied by an attendant lad with a lump of the material, rather more than sufficient to fill a small box, in shape a parallelopipedon, called a mould, containing about 150 cubic inches, in some parts of the country nearly 200 cubic inches, varying a little in size in most districts. The art of the brickmaker, or moulder, is the knack with which he throws, or drops, this soft clay into the mould, so as to fill up every corner. This is apparently a very simple process, and is the one to which I shall have to draw your attention this evening, and the accomplishing of which by machinery has caused a vast expenditure of time and money, and occupied the attention of many leading mechanics for some years. These moulds are emptied by being turned over on a board called a pallet board. The material used being soft clay, and the mould kept constantly wet by dipping in water between each charge (which is called slop-moulding), or sprinkled with sand or dust, the brick easily drops from the mould on its

being held over the pallet board. The bricks, when moulded, are carried or wheeled away to the hacks, or drying floors, where they are placed edgeways, about half an inch apart, or the thickness of the pallet board, one row on another until they form a wall 6 or 8 bricks high; they are then covered up and left to dry, ready for the burning. This latter process we shall discuss in a succeeding paper.

The number of patents taken out, connected with the manufacture of bricks, has been obligingly supplied to me by Mr. Carpmael; they exceed 230. It would be impossible to describe each particular machine, and I, therefore, propose to illustrate, as clearly as I can, the several principles which have been attempted by these inventors, and with what success. I shall not occupy you by references to the earliest inventions, as we know they were not successful, or they would be worked at the present day; but will notice those principles now before the public.

Before commencing with the manufacture of the brick, we must prepare the raw material—clay.

There are few places on almost the whole of the geological strata of this country, which do not possess alumina in combination with silica and other earthy matters forming a clay from which bricks can be manufactured. That most generally worked is found on or near the surface in a plastic state. Others are hard marls on the coal measures, new red sandstone and blue lias formations. It is from these marls that the blue bricks of Staffordshire and the fire bricks of Stourbridge are made. Marl has a greater resemblance to stone and rock, and varies much in colour; blue, red, yellow, &c. From the greatly different and varying character of the raw material, there is an equal difference in the principle of preparation for making it into brick; while one merely requires to be turned over by hand, and to have sufficient water worked in to make it subservient to manual labour, the fire-clays and marls must be ground down to dust, and worked by powerful machinery before they can be brought into even a plastic state. Now these various clays also shrink in drying and burning from 1 to 15 per cent., or more. This contraction varies in proportion to the excess of alumina over silica, but by adding sand, loam or chalk, or (as is done by the London brick-makers), by using ashes or breeze, this can be corrected.* All clays burning red contain oxides of iron, and those having from 8 to 10 per cent. burn of a blue, or almost black colour. These bricks are exposed in the kilns to great heat, and when the body is a fire-clay, the iron melting at a lower temperature than is sufficient to destroy the bricks, gives the outer surface of them a complete metallic coating. These bricks are common in Staffordshire, and when made with good machinery, (that is, the clay being very finely ground) are superior to any in the kingdom, particularly for docks, canal or river locks, railway-bridges, and viaducts. Other clays contain lime and no iron; these burn white, and take less heat than any other to burn hard enough for the use of the builder, the lime acting as a flux on the silica. Many clays contain iron and lime, but where the lime is in excess, the bricks are of a light dun colour, or white, in proportion to the quantity of that earth present; if magnesia, they have a brown colour. When iron is in excess, they burn from a pale red to the colour of cast-iron, in proportion to the quantity of metal, as I before explained.

There are three classes of brick earths:—

1st. Plastic clay, composed of alumina and silica, in different proportions, and containing a small per centage of other salts, as of iron, lime, soda and magnesia.

2nd. Loams, or sandy clays.

3rd. Marls, of which there are also three kinds; clayey, sandy, and calcareous, according to the proportions of the earths of which they are composed, viz., alumina, silica, and lime.

Alumina is the oxide of the metal aluminium, and it is this substance which gives tenacity or plasticity to the clay, having a strong affinity for water. It is owing to excess of alumina that many clays contract too much in drying. and often crack on exposure to wind or sun. By the addition of sand this clay would make a better article than we often see produced from it. Clays contain magnesia and other earthy matters, but these vary with the stratum or rock from which they are composed. It would be impossible to give the composition of these earths correctly, for none are exactly similar; but the following will give an idea of the proportions of the ingredients of a good brick earth; silica three-fifths, alumina one-fifth, iron, lime, magnesia, manganese, soda and potash forming the other one-fifth.

The clay, when first raised from the mine or bed, is, in very rare instances, in a state to allow of its being at once tempered and moulded. The material from which fire-bricks are manufactured, has the appearance of ironstone and blue lias limestone, and some of it is remarkably hard, so that in this and many other instances which I shall have to notice, in order to manufacture a good article, it is necessary to grind this material down into as fine particles as possible.

Large quantities of bricks are made from the surface marls of the new red sandstone and blue lias formations. These also require thorough grinding, but from their softer nature it can be effected by less powerful machinery.

The principal machines which have been worked for this purpose are three—1st. The pug mill. 2nd. The wash mill. 3rd. The rolling mill.

The pug mill is a cylinder, sometimes conical, generally worked in a vertical position, with the large end up. Down the centre of this is a strong revolving vertical shaft, on which are hung horizontal knives, inclined at such an angle as to form portions of a screw, that is, the knives follow each other at an angle forming a series of coils round this shaft. The bottom knives are larger, and vary in form, to throw off the clay, in some mills vertically, in others horizontally. Some have on the bottom of the shaft one coil of a screw, which throws the clay off more powerfully where it is wished to give pressure.

The action of this mill is to cut the clay with the knives during their revolution, and so work and mix it that on its escape it may be one homogeneous mass, without any lumps of hard untempered clay; the clay being thoroughly amalgamated, and in the toughest state in which it can be got by tempering. This mill is an excellent contrivance for the purpose of working the clay, in combination with the rollers, which I shall describe presently; but if only one mill is worked, I should not adopt it generally, for, although it tempers, mixes, and toughens, it does not extract stones, crush up hard substances, or free it from all matter injurious to the quality of the ware when ready for market. This mill can be worked by either steam, water, or horse-power; but it takes much power in proportion to the quantity of work which it performs. If a brick is made with clay that has passed the pug mill, and contains stones, or marls not acted on by weather, or lime-shells (a material very common in clays), or any other extraneous matter injurious to the brick, it is apparent from the action of this mill that it is not removed or reduced. The result is this, the bricks being when moulded in a very soft state of tempered material, or mud, considerably contract in drying, but the stones or hard substances not contracting cause the clay to crack; and even if they should not be sufficiently large to do this in drying, during the firing of the bricks there is a still furthur contraction of the clay, and an ex-

* Note.—Before commencing to work a bed of clay, in the first place it is necessary to ascertain its contraction in drying and burning. Secondly, how this can be corrected at the least expense if in excess. The necessary proportion of sand, lime, or chalk, would so vary with the clays, that no rule could be laid down, and it must be left to actual trial.

pansion of the stone from the heat to which it is subjected, and the result is generally a faulty or broken brick, and on being drawn from the kilns the bricks are found to be of inferior quality, commonly termed addled—that is, having no ring or metallic sound when struck—liable to great waste from breakage in carriage and otherwise deteriorating the ware. In the case of lime, on exposure to the atmosphere these shells, from absorbing moisture, lax or swell, forming lime powder, and in so doing burst the brick to pieces.

Next is the wash mill; but this I must merely glance at, as it cannot be practically worked for the manufacture of common bricks on a large scale, but only for front bricks. By a general adoption of good brick machinery, and a more general knowledge of the preparations of clays, we should have all our bricks equal in quality to what are now termed front bricks. This mill is a large circular trough, round which is a horse walk. The clay is worked in this trough with water by harrows drawn by one or two horses, until it is all thoroughly mixed up into a fluid state. It is then let off into a pit at a lower level through a grating or a series of gratings, which extract all stones and coarse undivided particles. In proportion to the fineness of these gratings or sieves, so is the quality of the clay. It is there left to subside, the water is then let off from the top, and the clay, when sufficiently stiff, is thrown out for work. By this means clay can be prepared of the finest quality. This is the principle on which china and earthenware clays are prepared after grinding. The expense would prevent its becoming general with brick-makers; and in the case of fire clays, marls, or any such earths as produce our best materials, it would be useless until they were ground down. It also consumes a large quantity of water, which could not be had in sufficient abundance in many districts.

I now come to the rolling mill, which is by far the most practical of all, and its general adoption throughout the kingdom would do more to improve the quality of our bricks than any other process. It consists of a pair or pairs of horizontal cylinders running near together, between which the clay is crushed. When bricks are made by hand, or a machine is used which does not pug the clay, I recommend the use of the pug mill, combined with the rolling mill. The clay passing first through the rollers and then through the pug mill, is ready for use.

All practical men must agree that you cannot have the clay in particles too finely divided, and this very fine division cannot be effected by that universally used pug mill. The first process is to crush or grind your material, and then to pug or work it. These mills are—in the case of fire clays, or any very hard rough substance, such as marls—series of pairs of rollers (generally three pairs) driven by steam. The clay is thrown into the top pair, which are set rather wide apart; the next pair are nearer together, and run at a greater speed, and the third, or bottom pair, are nearly close, and run sufficiently fast to take all the clay as the top pair throw it down. The clay enters these rollers a hard rocky material, and escapes from them entirely ground to a fine dust. For general works, a good single pair of rollers is sufficient. If a marl or hard substance is to be ground, the rollers must be larger in diameter than for unctuous clays, that their larger circumference may bite the marl and draw it in. If the diameter is too small, the lumps would ride between the rollers, and not be crushed without some trouble. For general brickworks a pair of rollers, 3 feet in length, and from 2 feet to 3 feet in diameter, will be found sufficient. The quantity of clay which can be prepared by these mills will be four times as much as can be done by the pug mill with the same power, and much better, as no portion of it can escape being crushed and minutely divided. These rollers are too often geared to run each at the same surface speed, but I have found that by running the one roller three times as fast as the others, (that is, gearing the wheels which connect the rollers at 3 to 1) a double action is obtained, not only crushing the clay and all hard substances into the finest particles, but also a rubbing action, which more thoroughly divides and amalgamates it, giving also more power to crush up a hard substance than by the pinch of equal rollers. The nature of clays varies so greatly, that no fixed rule can be laid down for their preparation, or whether a combination of rolling mills and pug mills are necessary, yet this process is most essential if a good article is required. In some works it is necessary to pass the clay through four pairs of rollers and two or three pug mills, while in another, at no considerable distance, from the difference of the clay, as fine a state of the material may be produced by passing it through a single pair of rollers. I dwell on this subject, as it so materially affects the action of machines and the quality of the ware when made; in fact, this is the groundwork of brickmaking, as it is of all pottery, from china downwards. If we look at pottery, the beautiful stone ware now produced, the large glazed socket pipes used in our town drainage, &c., these are made by machines, but the quality depends more on the preparation of the clay, or the fineness to which it is ground or crushed, than on the machine which moulds it. In most cases a good brick machine should take the clay after it has been crushed through rollers, and thoroughly amalgamate, or pug and work it, during its manufacture into bricks. Some clays require for a good brick machine little or no preparation, but these are rare, and they are fortunate who possess them. I have, therefore, only treated of those clays which are most difficult and expensive to work.

There is a system of preparation called screening; but this only answers for tilemaking, and that on a very small scale. A pair of rollers would do more, at less expense, and better.

If the London brickmakers would use rollers, and crush their clay and ashes altogether, so fine that no hard substance could be felt with the hand, their bricks would be of a very superior quality to what they now are.

There are other systems of preparation; but I have treated of those most universally adopted.

The next process is the manufacture of this clay into bricks; and I cannot refrain here from mentioning what an injurious effect the present system of hand-making has on the habits of the men. The brickmakers (that is, the moulders and their attendants), men and lads, are, throughout the kingdom, employed at their trade only during six or seven months in the year, except where bricks are artificially dried, in the neighbourhood of collieries. In the winter season, the bricks would be destroyed by frost; neither could they then be dried. They therefore work early and late; and from their having no winter occupation, and on account of their dirty and laborious work, they have such a price per thousand as to compensate them. The result is generally, among this class of men, that, although they are so well off in the summer time, they spend all they earn, leaving the winter to provide for itself. At that season, when they require most to sustain both themselves and their families, as well as fuel, they have nothing to fall back upon, and in too many instances no employment; for, as they earn so good wages in the summer, they do not willingly come down to the price of ordinary labour. These are the men whom the introduction of machinery will affect.

Before entering on the manufacture by machinery, I should state that brickmaking was carried on till within the last few years with comparatively few attempts at improvement. Until the duty was taken off, in 1850, the regulations of the Excise were so strict that any attempts at progress were frustrated; but, since the above date, most rapid strides have taken place. Machinery has been constructed on all seemingly possible principles to produce this ware in greater quantity, and of superior quality; so that, as far as mechanical make is concerned, it may be called a new manufacture. Although machinery had been worked for many years, it attracted little attention, from its frequent failures in practice. For this reason, new plans have been introduced for the forming of clay

into bricks. I shall therefore feel it my duty, in describing these machines, to point out those parts of the several principles adopted which have prevented their being more generally used.

Brick machines are now very cautiously watched by the makers, which is a matter of no astonishment; for so many machines have been brought out without a due consideration in their construction of what is required by the brickmaker, and many have been introduced by mechanics not at all conversant with brickmaking generally. When they had succeeded in forming a block of earth of the required size, they thought they had attained all that was necessary. I would recommend all, before purchasing, to see a machine in regular every-day work, and to minutely examine the ware which is being sent out for use, the production of the machine.

In a former part of this paper I have mentioned that we wish to manufacture by means of machinery a rectangular block of clay about 10 inches long, 4⅝ inches wide, and 3¼ inches deep, containing some 154 cubic inches, into as compact, hard, and durable a material as a block of stone.

There are four principles on which these machines effect this, one of each I shall briefly describe. 1st. By moulding the dry clay (that is, clay containing only sufficient moisture to allow its particles to adhere, when subjected to considerable pressure) by powerful machinery; 2nd. by imitating the old process of hand-making, filling moulds with soft-tempered clay like mud; 3rd. by forcing clay in a stiff plastic state through dies or apertures the size of a brick, endways or edgeways (a die is a plate with a hole cut in it of the shape which is desired to be given to the clay); and, lastly, forming a stream of clay to the desired shape by rollers.

I will, before explaining these in detail, describe the general principles on which clay is forced into or through these dies and moulds.

The oldest plan of working clay down, and pressing it off through any given aperture, is the pug mill, which I have before described in the preparation of the clay. This mill is used by both classes of inventors to fill moulds traversing under its delivery, to express the clay through dies, or to fill the material into boxes in which work plungers or pistons to force the clay out through a die as soon as it has received its charge. Next, we have pistons worked by all sorts of mechanical contrivances, of wheel-work and racks, cranks, eccentrics, screws, &c., forcing the clay from boxes or cylinders in which they traverse backwards and forwards, and so by their downward passage force the clay through any given aperture or die. These machines lose much time, as during the up or return passage of the piston all brick-making is at a stand. Another expressing machine, the patented invention of Mr. Ainslie, is a pair of rollers or horizontal cylinders, driven at a like surface speed, having one side closed, in front of which is the die. The rollers being driven, draw the fed clay through between them, and force it out in one continuous stream of the desired shape.

The next, and, as I have found in my experiments, the most powerful, is a screw fixed on a shaft hung through the centre of a cylinder. The screw in revolving carries the clay down its thread, and not only forces it on with immense power, but so works the clay in its onward passage as to be equal to the pug mill when used in combination with a rolling mill. The clay naturally adheres to the stationary surface of the cylinder, and the screw by its revolutions keeps it in a constant state of motion, and rolls and works it, and when it arrives at the end it is forced on through any required orifice. An example of this is before you in the pug mill part of my machine, but with the addition of knives on the thread of the screw.

To explain the whole of the mechanical contrivances invented for forcing and expressing clay, either through orifices or into moulds, would not aid us in the practical manufacture of bricks, and would, without drawings, occupy too much of your valuable time.*

The first plan adopted which I propose to discuss is that of moulding dry clay, or clay as dug from the earth. This has been worked on several principles. The dry clay American machine is about the best example of this class. The clay is merely dug from the earth, and ground through rollers from which it falls into the hopper of the machine. The bottom of this hopper is a cast-plate in which are 14 brick-moulds. This mould plate is rather more than double the length of the hopper, and travels backwards and forwards, being driven by wheel-work; so that while one-half of the plate, containing seven moulds, is being filled under the hopper, the other seven are being emptied outside. The moulds have moveable bottom plates or pistons, which are forced up by an inclined plane as soon as they are free from the hopper, and throw out the bricks contained in them. The moulds are filled as they traverse backwards and forwards by having to pass under a wheel which presses the clay into them. This wheel is hollow, and is filled with steam to heat it, so that the clay may not adhere. I have known an instance on a railway, where the bricks, made of blue lias clay by this machine, were so smooth on the mortar surface, that bridges had to be taken down and re-built, because the mortar would not adhere to them. Others force the clay down cylinders into moulds by means of a screw, and some by hydraulic pressure produce a brick ready for the kilns. But these machines are not likely to come into general use, for they have to exert so great a force in order to press the comparatively dry material into the moulds so as to fill all corners (here is the difficulty and the consumption of power), and at the same time so to compress the clay, as to make it sufficiently firm, not only to adhere, but also to withstand the weight of 30 or 40 deep, one row on another, in the kilns. There must necessarily be an immense amount of power consumed for the purpose of obtaining what is considered a more solid and durable brick. But this is an error which I shall shortly explain. This class of machinery is very expensive. The American, with the engine, costs upwards of £1,400. These machines average the consumption of 20 horse power to drive them. A breakage with this large machinery is very serious, and of too frequent occurrence. I shall be met by the promoters of these machines with the advantage of working up dry clay, saving the whole process of drying the bricks, the labour of carrying to the drying ground, and again removing to the kilns, also with being able to work all the year uninterruptedly, and independently of seasons. But with how few clays can this be accomplished? The clay is not really dry; it has sufficient moisture to allow it to adhere and give it toughness to support the weight of the stack in the kilns. The great pressure to which it has been subjected in the machine makes it so compact a mass, that it would take a long time thoroughly to dry it. The result would be, in plastic clays, if this principle were generally adopted, that when the firing of the ware was commenced, the outer surface would be dried, but from its close texture the moisture in the centre could not evaporate. The greater heat, as the process of firing proceeds, makes the brick hot, and the moisture in the centre, forming steam, would in most cases blow it to pieces. In many clays the outer surface will shell off, but in others of a more open character, that is, of a more loamy kind, it would be only partially rent, and this would generally cause the bricks to be less solid and compact than those made from tempered plastic clay, which in drying has become sufficientiy porous to allow this steam to escape. The firing of the ware made on this principle is as great a drawback as the expensive machinery necessary. The clay being so powerfully compressed into the moulds, is held on every surface

* I recommend a continuous delivery, with a good preparation of the clay; and that on the principle absorbing least power.

by adhesion. When the pressure is taken from the top, and the piston or bottom of the mould begins to rise, the outer surface of the brick adheres so tightly to the inner surface of the mould, that it takes great power to move it. The centre of the brick, in some clays, rises a little the first, and causes one mortar surface to become slightly concave. The outer edges drag, from the great friction they have to encounter in being freed from contact with 90 inches, or a square surface of more than half as many superficial inches as there are solid inches in the brick itself. These machines are better adapted for marly than plastic clays.

I will now take the working of clay in a soft state, or of the same temper as for hand-making.

The machines for this purpose have all necessarily adopted the principle of moulding, which is much more easily performed than with dry clay, as not more than about four-horse power is required. We have the same duty to perform as with dry clay, viz., to fill each corner of the mould and to expel all the air. A machine of this class was introduced some few years since by Messrs. Ransome, of Ipswich, from America. (Hall's machine.) This was a pug-mill, which forced the clay into a series of six moulds. A man in attendance, by wheel-work, gave the clay a pressure into the moulds with one leverage, and with another drew out from under the machine the six full moulds, the same action replacing them with six empty ones. Although largely used in America, it did not become general here. The difficulty in this class of machinery is, that while the moulds are being drawn from under the pressure of the clay, directly one part of the mould is clear, the pressure, which is on that part of the brick still under the machine, lifts or forces the clay upon that side or end which is free from pressure; and when delivered, the bricks are of unequal thickness.

One machine, the London Company's Brick Machine, corrects this by striking or cutting off this superfluous clay after it has left the mill or pressure.

Machines working soft clay have several disadvantages for the brick-field; the material being in such an almost fluid state, the bricks are very subject to be injured in form in being carried off. Nor are these machines sufficiently portable to be easily moved each day as the drying ground is filled round them. The clay being worked in so soft a state, the great evaporation in drying leaves the bricks very porous, if it is a loamy clay, or causes them to undergo an excessive contraction if a strong one. Neither are they sufficiently stiff to be delivered from the mould by the machine, but would have to be taken off by hand and emptied, which is a very slow process and incurs considerable manual labour, as the machine requires not only to have the moulds taken from it and emptied, but also to be fed with them again. In brick-making by machinery, we should employ as little labour as possible, but should give the machine the raw material and take away the manufactured article without any intermediate labour. It is, in my opinion, a serious objecjection to have to feed a machine with moulds, as is generally done in this class of machinery. In making 15,000 bricks a day, and calculating the moulds to weigh 4lbs. each, which is a low average, as they are generally made of metal, we have to employ the extra manual labour of taking off, and again feeding on the machine (two removals) rather more than $53\frac{1}{2}$ tons of iron, or of whatever the material the moulds may be composed; while the whole weight of clay for the day's work is not more than 75 tons. Unless the machines can be easily moved from day to day as the drying ground is filled, great additional labour will be incurred; for the softness of the clay will not allow the bricks to be roughly wheeled, and they must be transported very carefully.*

I now come to brickmaking by machinery with clay in a plastic state, but of such a stiffness that the bricks, when made, are too firm to lose their form in carriage or removal from the machine to the drying ground, or in that state of temper in which it will make, in most clays, the best and soundest article, if properly mixed and prepared, having only sufficient moisture to allow of its being thoroughly amalgamated. This clay will make bricks which, when well burned, will have a very metallic sound on being struck; and this is the best proof of their solidity and close texture.* Bricks are made with clay in this state by moulding; by pressing through dies; by forcing through dies with tongues or cores (making hollow or perforated bricks); and, lastly, on the principle of my own machine, by taking the stream of clay from any expressing machinery, and forming it into a block by rotating surfaces. Moulding is subject to the same difficulties which I have described in soft clay—the lifting in the end or side of the mould first relieved from pressure, though not to the same extent. But it takes considerably more power to drive the machines, and to fill the clay into the bottom corners of the moulds. In these machines the bricks are delivered from the moulds by pistons, as in dry clay, but are more subject to swell on the upper mortar surface, and to drag on the sides of the moulds.

There are many principles on which the moulding of the clay is worked; but the limits of this paper will not allow of my explaining them. The system of forcing the clay through dies the size of a brick, edgeways, and then dividing the stream of clay into bricks by a frame of wire three inches, or the desired thickness of the brick apart, has been tried by several; but here arises another difficulty—viz., to get a good smooth square corner or edge to the stream of clay as it escapes from the die. The large aperture through which it is forced, fifty square inches, does not offer a sufficient resistance to force the clay into the angles of the die. Clay, when expressed through an aperture such as this, travels fastest in the centre, having less friction or resistance through its own substance than over the smoothest metal, wood, or any fixed matter. Clays travel, when forced, in the same manner as water running through the same space. The centre of the stream, having the least friction, travels fastest; while the outside, from the friction of the stationary surface which it has to travel over, does not flow so fast. So it is with clay; that which escapes through the centre, meeting with no resistance, travels as fast as the power forces it forward; but the outward surfaces are constantly dragging against the stationary metal or wood of the die, and more particularly so at the corners, the clay escaping with jagged or saw-like edges. The corners of the square die have the smallest body of clay to contend with the largest amount of friction. To remedy this, Mr. Heritage brought out his patent water die, which is a double die, or escaping aperture, with the intervening space filled with water. The clay, after leaving the actual die with a rough edge, passes through the water, and then through the second smaller die, which greatly improves it. Another machine, Mr. Clayton's, was introduced to obviate the difficulty of a rough edge, by having the two ends of the die to rotate. This was an improvement in the right direction. When the clay is delivered from machines on this principle it has yet to be divided into bricks. The stream of clay is, in most instances, in constant motion, and in order to make 15,000 bricks per day, must travel seven feet per minute. The machines hitherto introduced cut off these bricks while in motion at right angles to the die, but having no compensating motion for the onward movement, they depend entirely on the speed with which the man can pass the frame of wires

* Patent Brick Machine Company.—Since writing the above, I find the Patent Brick Machine Company have improved their machines; and, according to a circular I received this morning from the Secretary, Mr. Mount, they now work the clay in a much drier state than it can be moulded by hand. It should not, therefore, come under that class of machines in which I have placed it. It is also portable.—H. C.

* There are exceptions, but this is generally the case.

through the stream of clay. It is, therefore, impossible for them to make a square cut, and if at all nearly correct, they must work so slowly that the advantage of the machine is lost. A brick machine, to be perfect, should effect this, and not depend on manual labour. If the clay is travelling at the rate of 5,000 bricks per day, a man cannot cut them off square, while in motion, with a cutting apparatus working at right angles to the die. If there is a compensating motion on the wire frame, we have still equal difficulties to contend with; either the stream of clay escaping from the die does not travel at one uniform speed from irregular feeding, or the man in attendance draws his wires too slowly or too quickly to cut correctly. We have an example of this cutting in the Ainslie Co.'s tile machine, and a brick machine was exhibited at the Royal Agricultural Society's meeting at Carlisle last year on this principle, by Messrs. Porter, Hind, and Porter. The machine itself must do this with mechanical truth.

The most universally used die machine which has been extensively worked up to the present time is Mr. Beart's patent for perforated bricks. This gentleman, who is practically acquainted with these matters, in order to remedy the difficulties I have mentioned in expressing a mass of clay through a large aperture or die, hung a series of small tongues or cores so as to form hollow or perforated bricks. By this means the clay was forced in its passage through the die into the corners, having the greater amount of friction now in the centre. Still, the bricks came out rough at the edge with many clays, or with what is termed a jagged edge. The water die was afterwards applied to this machine, and the perforated bricks, now so commonly used in London, are the result. In Mr. Beart's machine, which is a pug mill, the clay is taken after passing through the rolling mill, and being fed in at the top, is worked down by the knives. At the bottom are two horizontal clay-boxes, in which a plunger works backwards and forwards. As soon as it has reached the extremity of its stroke, or forced the clay of one box through the die, the other box receiving during this time its charge of clay from the pug mill, the plunger returns and empties this box of clay through a die on the opposite side of the machine. The result is, that while a stream of clay is being forced out on one side of the machine the clay on the opposite side is stationary, and can, therefore, be divided into a series of five or six bricks with the greatest correctness by hand. Some of these machines have both boxes on one side and the plungers worked by cranks. This machine cannot make bricks unless the clay has previously passed through rollers, if coarse, for anything at all rough, as stone or other hard substance, would hang in the tongues of the die. But the clay being afterwards pugged in the machine, is so thoroughly tempered and mixed, that the bricks when made cannot be otherwise than good, provided they are sufficiently fired. As to the utility of hollow or perforated bricks, that is a matter more for the consideration of the architect or builder than for the brick-maker. Perforated bricks are a fifth less in weight than solid ones, which is a matter of some importance in transit; but it takes considerably more power to force the clay through those dies than for solid brick-making. In the manufacture of perforated bricks there is also a royalty or patent right to be paid to Mr. Beart.

Having thus explained the principles on which mechanics have attempted the manufacture of bricks, and not considering any of them quite perfect, I turned my attention to what was the cause of failure in these several principles.

In the moulding of clays in a dry state by machinery we have to employ great power and large expensive machines to force the clay into the corners of the moulds, and to sufficiently press it, so as to make it adhere. When we do succeed in making from the clay a nice true block, in appearance all we could wish, it has then to go through the ordeal of firing, from which with but few clays it would come out sound. Nor must we forget the serious and too frequent losses by breakage of these machines.

Next in moulding clays in a medium or stiff plastic state, and also in a soft plastic state, when the mould escapes from the pressure of the clay, that part which first leaves the machine is apt to be forced up above the mould, causing that end or side to be thicker, and in those which lift the brick out of the mould by pistons, from the clay dragging, that is, adhering so tenaciously to the inner surface of the moulds, an effect is produced of making one mortar surface concave. There is also a great wear on the moulds, from the pistons which lift the brick travelling in the grit of the clay; this soon cuts them larger, and the pistons must require frequent renewal.

Those machines which force the clay through dies to make solid bricks, should deliver it the length and depth of a brick edgeways, so as to cut every 3¼ inches, that the rough surface left by the wire may be the flat of the brick which forms the mortar joint. We have traced the difficulties of the dies, and also the imperfections of the cutting arrangements generally used. I came to the conclusion that for a brick machine to become generally useful, it should embrace the following advantages, and these I have attempted to realise. First, it should be portable, in order to save labour in carrying off. It should amalgamate or pug the clay, and then form it into a stream of material the size of a brick edgeways, and divide it into bricks by the action of the machine itself. It should have no cessation, but be intermittent in its action; it should work at great speed, that is, deliver off its bricks as fast as it is possible to remove them. To produce 15,000 per day we have to pass 75 tons of clay through the machine, and to make solid and hollow, or perforated bricks, with equal facility; in fact, I do not consider any machine perfect which requires assistance in cutting off or otherwise. As I before remarked, a machine should be fed with the raw material, and deliver out, without any assistance, the manufactured article, with the consumption of as little power as possible.

I shall now explain the action of my own machine, an example of which is before you.

The clay is fed into a pug mill, placed horizontally, which works and amalgamates it, and then forces it off through a mouth-piece or die of about 65 square inches, or about half-an-inch deeper and half-an-inch longer than is required for the brick, of a form similar to a brick on edge, but with corners well rounded off, each corner forming a quarter of a 3-inch circle, for clay will pass smoothly through an aperture thus formed, but not through a keen angle. After the clay has escaped from the mill it is seized by four rollers, covered with a porous fabric (moleskin) driven at a like surface speed from connection with the pug-mill.* These rollers are two horizontal and two vertical ones, having a space of 45 inches between them; they take this larger stream of rough clay, and press or roll it into a squared block of the exact size and shape of a brick edgeways, with beautiful sharp edges, for the clay has no friction, being drawn through by the rollers instead of forcing itself through, and is delivered in one unbroken stream. The rollers in this machine, perform the functions of the die in one class of machinery, and of the mould in the other. They are, in fact, a die with rotating surfaces.† By hanging a series of mandrills or cores between these rollers, or by merely changing the mouth-piece, we make hollow and perforated bricks, without any alteration in the machine. The pulley which drives the belt working these rollers, is not of sufficient diameter to be able to draw the clay away from the mouth-piece, if the man feeding the machine should neglect his work. This small pulley runs loose in its strap, leaving all the

* The feeding these rollers with a stream of clay by means of the die falls within the claims of a Patent taken out by Mr. Clayton. I have, therefore, made arrangements with that gentleman for the use of that part.

† The original inventor of using rollers to compress the clay into any desired shape was the Marquis of Tweedale.

details of the machine stationary until more clay is fed into the mill, when it again immediately resumes its functions. The bottom roller carries an endless belt, on which the stream of clay is delivered to the cutting-frame. This carries a wire, which is constantly traversing at a compensating angle, while the clay is in motion, and thereby makes a square cut. After it has divided one brick, it changes its action and cuts off the succeeding one at the opposite angle to that which it had previously traversed. This wire is put in motion from gearing in connection with the rollers, which press the block of clay into the shape of a brick, and thereby acts with mechanical correctness. For if the smallest portion of clay escapes from the mill, motion must be given to the rollers, or rotating die by the driving strap, and from them to the cutting wire. The bricks, as fast as made, are passed on by the machine to boys in attendance, who receive them on pallet boards, and remove them to the drying floors or hacks. It will be seen that I form my brick or squared block of clay with less power and friction than by moulds or dies, that no resistance is offered to the clay, but that, on the contrary, it is impelled forward by the driven rollers; that from the machine itself cutting off the bricks at an angle, compensating for the onward movement off the clay, not only a true cut is made, but also the intermediate labour required by most other machines is saved. This machine, with four-horse power, will throw of bricks, if fed with clay, faster than it is possible to remove them. Another advantage in the pug-mill is that the clay is thoroughly amalgamated. Bricks can be made by this machine for one half the cost of hand-making. If it was employed for thirteen weeks, making only 15,000 a day, the saving of labour would purchase the machine; and each machine occupied throughout the year would effect a saving of £600 per annum. Besides this, the superiority of the bricks made by it commands a higher price in the market. Four hundred of these machines occupied throughout the year would make all the bricks required for the use of this country, and effect a saving of £240,000 a year in labour.

I trust you will not think me egotistical in thus dwelling on my own invention; but it is the result of many years' careful thought, and many very expensive experiments. As it is a subject with which I have been closely allied for the last fifteen years, I flatter myself that I have introduced a machine that is adapted to the requirements of the practical brickmaker. I should mention that brick-machines generally are large fixed machinery, of great weight. I allude to this that you may not form an erroneous idea from the small affair now before you. I exhibited this machine for the first time on the 6th of September last, at the Liverpool and Manchester Agricultural Society's Show, at St. Helen's, when I was awarded a silver medal. I was there timed as to my make, and with 25lbs. pressure on one of Clayton and Shuttleworth's 6-horse-power portable steam-engine, at 45lbs. per inch, I made 35 bricks per minute. I next exhibited it at Coleshill, to the Warwickshire Agricultural Society, and was awarded a prize; next at Leek, at the meeting of the Staffordshire Agricultural Society, when I was again awarded a silver medal and a prize. I have since shewn the machine at Worcester, where it was awarded a fourth prize. I have never publicly exhibited it at work without receiving a prize or a silver medal. I shall show it at work during the show of the Royal Agricultural Society at Chelmsford next month. All this is apparently of little moment to a meeting like the present, but it is a matter I feel bound to mention, as I know of no other brick-machine which has received such distinction in this country, and I have no doubt it was the cause of my having had the honour of receiving the invitation of this Society to read a paper on the subject. I must also plead for your indulgence for having so long dwelt upon my own invention.

I much regret that, from being occupied in business, I have not been able to devote that time to the preparation of this paper which I could have wished, but if it is the means of opening a discussion among gentlemen present, I shall have attained the object aimed at by this Society, and from it I hope to derive further knowledge on a subject in which I take great interest.

DISCUSSION.

Mr. Robert Rawlinson, C.E., (in a note to the Secretary,) said he had paid much attention to the manufacture of bricks by machinery, having used them on a large scale in the great ceiling at St. George's Hall, Liverpool. These bricks were made by Mr. Scraggs, of Tarporley, in Cheshire, in a common land-drain tile-machine. The idea was taken from a land-drain. The bricks were twelve inches long by four inches square, with a longitudinal perforation of two inches diameter. In fact, a two-inch field-tile, made four inches square instead of being round. All the bricks were set "headers" in the arch; and this arch, which was seventy feet span, was only one brick in depth, or twelve inches, being the largest span and the lightest arch in the world. Machines could make bricks of any sectional form; and moulded bricks, or rather, bricks to form mouldings, might be made as easily as plain bricks. At present there were not makers sufficient to supply the demand. He had specified, several times within the last five years, for machine-made bricks, but had had to resort to hand-made ones, either because there was no offer, or a most extravagant one for machine-made bricks. In the year 1849, he (Mr. Rawlinson), in his report to the General Board of Health, on an enquiry into the sewerage, &c., of Birmingham, entered very fully into the question of the manufacture of bricks, and the comparative efficiency and cost of hand-made and machine-made bricks, and of hollow tiles and solid bricks.

Mr. Beart (of Godmanchester, Huntingdonshire) said that but for the observations of Mr. May, and being called upon by the chairman, he had not intended, nor was he prepared, to say anything upon the subject before the meeting. Mr. May alluded to his services having conferred a great boon upon the agricultural interest in being the first to introduce machinery for making tiles, and causing a reduction in their cost for land-draining purposes. Mr. Beart stated that in 1832 he took out a patent for a machine for making tiles, and the result was, that tiles, which had previously been selling at 36s. per thousand, were at once reduced to 20s.; and in the neighbourhood of his works, in Huntingdonshire, they were now selling at a still lower rate. The effect, also, in other parts of the kingdom had been to reduce cost. The year 1842 might be taken as the period from which the greatest improvements and advance had been made in adapting machinery to supersede the making of bricks by hand labour. In that year machines were introduced for expressing clay by pistons and other means through dies, having orifices for making bricks either solid or perforated, also pipes and tiles for land drainage. It was not his intention, without consideration, to discuss the subject of brick machinery, further than to say such machinery stood in a different position to machinery in general. A machine that would spin cotton in Manchester would do the same in any other place, but this was not the case with brick machinery, which must be adapted to the peculiar clay it had to work. Clay varying in different localities, required different arrangements of machinery for its working; and upon some clays, or mixed substances of which bricks were made, no machinery had up to the present time been brought to bear. In the conclusions arrived at by Mr. Chamberlain, there were one or two points in which he begged to differ. That gentleman stated that solid bricks, when made very dense, of plastic or adhesive clays, would, on burning, break or fracture, from steam generated by heat in the interior of the brick not being able to escape. This was not philosophically correct. Clay being a substance which

contracted both in drying and burning, if the surface was dried too rapidly, and before the moisture escaped from within, the outside would contract before the inside; consequently, fractures would in such clays take place, and great breakage in the drying and also burning, so that, commercially, the waste in manufacturing was too great to enable the brickmakers to produce bricks at a marketable price. In perforated bricks this difficulty was in a great degree overcome, as the perforations reduced the quantity of clay, enlarged the surface for the evaporation of moisture in drying, and admitted the fire in burning. Bricks made in this manner could not only be produced at a lower price than solid ones, but were free from fractures, and the operations were rapidly completed. He must also dissent from the observations upon fire bricks. If the clay for such bricks were reduced to an impalpable powder, and by machinery made over dense, they would cease to possess the power to resist the sudden transitions from heat to cold which they were frequently subjected to. Being once consulted by an eminent fire-brick maker on the manufacturing of such bricks by machinery, some tests were made, the result of which was that a burnt brick made of fire clay in the ordinary manner was thrown into a furnace at a white heat, and when raised to the furnace heat was taken out and suddenly immersed in cold water without injury to the brick. A tile made of the same clay (the clay having been first reduced to powder and afterwards made dense by the machine) was subjected to the same test, when it was split to fragments; the reason being that the clay was reduced to so fine a state that the rapid passage of heat was prevented, and hence unequal contraction and expansion arose. The fire-bricks first tested being made of larger or granulated particles of clay, allowed the heat to pass rapidly through, so that this defect did not occur. In the same way it was easy to account for the breakage of glass, pottery, &c., when of considerable substance, by unequal contraction and expansion.

Mr. Charles May, F.R.S., produced a specimen of the American dry brick, which, he said, contained only about half the cubical contents of the bricks generally used in this country. This brick was formed of clay compressed in a dry state. It was extensively used in America, and its density was very great, being only one-ninth less than that of granite.

The Chairman.—Almost metallic.

Mr. May then alluded to a specimen of brick made from London clay, which, he remarked, militated against the statement of Mr. Chamberlain, inasmuch as it was made from clay without any preparation beyond watering and pugging, and was made by Beart's machine. He had also a brick made from the same clay, and compressed and dried. It was, however, imperfect, because, having been set in the kiln with ordinary bricks, the outside had become covered with steam from the evaporation of the bricks, and, therefore, did not present a very favourable specimen. The manufacture of a very beautiful description of brick was being carried on by Mr. Minton from dry clay, and he believed Mr. James Nasmyth had recently patented some improvements. The clay was not, of course, perfectly dry; it was so far re-damped, that if a lump were grasped, it would maintain its form like moulding sand. There were, in the first instance, some difficulties to be surmounted, but they had been all overcome, and a uniformly sound brick was now produced. He did not think the plan of working dry clay would answer in this country. It would not pay to evaporate the moisture from the clay by artificial means, and they had not a sufficient continuation of dry weather to do it, as was the case in America. A very good account of the manufacture of this description of brick was given in Mr. Whitworth's report upon the American Exhibition. Although he did not think that system of manufacture could come into general use in this country, yet, in a dry country, like America, it answered very well. There had been an establishment near Hanwell, for making these dry bricks, but it was now discontinued. The principal difficulty of that plan was the keeping up the corners of the bricks. He himself had taken out a patent for manufacturing perforated bricks with dry clay, but, other avocations interfering, it had not been worked, although he thought it might be used with good results. The principle of the thing was, filling the mould and perforating the brick in such a manner that the clay was squeezed out into the corners, and so reducing the quantity of material required, and giving greater facility for the material to spread outwards, and fill out the corners most completely. With regard to the quantity of material saved in the brick produced by Mr. Chamberlain, it would be found, he believed, not to come up to 20 per cent. The specimen before him, produced by Mr. Chamberlain's machine, was 9 inches by 4½, and contained about 39 square inches. The perforation were not more than 5-8th's of an inch in diameter.

Mr. Chamberlain—11-16th's.

Mr. May took these perforations to be 5-8ths, which would in the aggregate make about six square inches of surface removed; and he thought the saving of material in this instance was not more than 15 per cent., if it even exceeded 12 per cent., and in no case he believed did the saving of material in the perforated bricks come up to 20 per cent. But the disadvantage was, that these bricks broke very much in the carriage when made of the description of clay of the specimens produced; but there were other clays which were not so brittle. There was a white brick made at Mr. Beart's establishment, at Arlsey, which was not so liable to break, the beauty of the colour of which he believed exceeded anything yet produced.

Mr. Henry Clayton would make one or two observations with reference to a portion of the machine exhibited, the important portion of which, he believed, he had the right to say was his own invention, and for which Mr. Chamberlain had taken a license under his patent, —that which he might say gave life to the machine now before them, and without which it would not be a brickmaking machine. He referred to the rollers between which the clay had to pass after leaving the fixed die or moulding plate. The system now in operation, or rather as shown in Mr. Chamberlain's machine, formed the subject of a patent of his (Mr. Clayton's), taken out in 1852. Some ten months after that he obtained a second patent, for a still further improvement upon the same process. It had been his study, for many years, to perfect that class of machine in every detail. As had been stated by Mr. Chamberlain, the difficulty in an expressing machine for making bricks was to produce a stream of clay properly formed with sharp angles, and with a surface fit to be used for building purposes. For the reasons already explained by Mr. Chamberlain, the great friction of the clay upon the sides of the fixed die or orifice, and especially the greater friction in the angles of the orifices prevented the clay protruding from the die. It expressed the clay so badly in some cases, as nearly to separate the stream of clay into two parts. He found that the clay could not be expressed through a die having fixed sides. This led him to contrive an orifice having two of its sides to rotate and travel in the same direction as the clay was being driven. His first means was to make the fixed die of a larger size than the intended size of the brick, and to place it at a convenient distance, from a series of rollers, through which it was afterwards to pass. This system was not identically that which was represented in the machine before them. He formed a vortex by using rollers which were connected by endless bands, the clay then having an opportunity of entering much larger than when it left of the finished size. It succeeded to a certain extent satisfactorily, but not completely so to him, and he was, therefore, led to take out a further patent. He found that what he was doing by two distinct means, viz., by a fixed die first, and afterwards by rollers, could be accomplished more simply and effectually by combining the two in one. He then origi-

nated the moulding die, or orifice, with rotating sides, or over and perfectly under, as the case might be, and he found it to succeed. He found it requisite to have some friction upon the sides of the die. If they passed the clay without some degree of friction, in the attempt to overcome the difficulty by having only a fixed die, they found a mis-shapen mass of clay. Having tried a series of rollers without fixed orifices, he found that would not succeed, and it was only by great application and perseverance that he overcame the difficulty. He formed a die having two fixed sides, and also two sides to rotate, and then he considered he had solved the problem of making bricks by an expressing machine, without reference to the particular kind of machine employed. By attaching that system of die they could produce the stream of clay to be made into bricks. The description of clay to be used was a matter for the brickmaker, not for the machine maker. He had, however, paid some attention to the subject of clay; that was indispensable in order to get a good quality of brick, inasmuch as a tough waxy clay was liable to shrink and fracture. With regard to the application of the screw to propel the clay forward, which had been adopted in Ainslie's machine, it would be found that the clay took a circular form, and if they examined the bricks minutely after burning, they would find that they were not sound, but there was a circular fracture in them, which was most objectionable. That was, in his opinion, the great objection to the screw, and led him to abandon it. Instead of adopting that principle, he had formed a chamber within the cylinder of the machine, and at the bottom of the machine—different to all others—not a chamber *under* the machine, but *within* the body of it, and by means of cranks and arms he obtained a continuous delivery of the clay, first from one side and then from the other, and by this means his clay was in a state of rest when being cut. He had found it objectionable to have the clay in motion when being cut by the machine. When it was in motion, unless the boys employed to pass the cutting wires were very active and attentive, the bricks were apt to be cut one-sided. It became his object, as a machine-maker, to remedy that, and, he believed, he had succeeded, and not only so, but he had also accomplished the object of avoiding fractures. He presumed there were many brickmakers present who were more practically acquainted with the subject than he was. A machine for making bricks must be of a large character to be beneficial; the first and most indispensable part of brickmaking was that the clay should be effectually prepared, and, as they were aware, clay could not be handled in a small space; consequently, if there must be space within which a sufficient body of clay could be tempered, they must have a large space to receive the clay to be tempered; hence the machine must necessarily be large, or, at least, the cylinder must be large, and then they had the opportunity of feeding the clay in the manner that was ordinarily practised in the brick-yard, with a tramway and truck similar to a miniature railway, by which means large quantities could be rapidly fed, without which, he considered, a brick-making machine was much at fault. It was necessary that the clay should be put into the machine unpugged, and that the pugging should be done by the machine itself, if they wanted to make cheap bricks, and that was a system very different to the machine before them. As a machine-maker, he would say that, with so small a receptacle to pug and temper the clay, it could not be done properly. He would say, further, with so small an aperture with which to feed the clay—being only about the size of a brick—it was practically impossible to work the machine to produce that quantity of bricks which could be commercially advantageous. It was evident the clay must be made into pieces of a given size, and that he did not call practical brickmaking. The clay ought to be put in by barrow or truck; it should then be carried continuously forward, as was done in the ordinary pug-mill, which was the best machine for preparing the clay that he knew of; and as the proper tempering of the clay was the foundation of good brickmaking the machine ought to do that. This being a matter so imperative, it was one of the first points to which he turned his attention, and he had been more successful in that respect than he could have anticipated. He had tried a great many experiments—some of which failed. The things to be considered were—first, the pocket—and, in the next place, the persons working the machines were not generally mechanics, and, therefore, they wanted a machine which would work without much trouble or attention on the part of the workmen employed at it. The cylinder in his own machine would hold about 1½ cubic yard of clay. With his machine, from 20,000 to 30,000 bricks could be produced per day, varying according to size; which, he believed, was as much as had ever been accomplished by the aid of machinery.

Mr. Austin, as a practical brickmaker, bore his testimony to the immense advantages to be derived from machine-made bricks, and also spoke in high terms of the general efficiency of Mr. Clayton's machines, as well as those of Mr. Ainslie's. He confirmed the views expressed by Mr. Clayton as to the necessity for having a large space to collect the clay and the continuous feeding of the machine, and said he gave the preference to machines which would take in from a cubic yard to a yard and a half of clay. There might, however, be an objection to large machines, on the ground that they were not portable; but, generally speaking, he thought a very portable article was not required. He also expressed his approval of the method of cutting the bricks when the clay was in a state of rest, without continuing the propelling motion at the time of the operation.

Mr. C. H. Smith said, that a general practice with the hand brickmaker was to sprinkle dry sand in the mould every time previously to filling it with the moist clay. No doubt this plan prevented the inconvenience of the clay adhering to the mould; if this were its only use, any other dry fine-grained powder might answer the same purpose, but he had reason to believe that the sand being quartz or siliceous grains, performed a far more important part in the manufacture of good bricks. First, in the process of burning, the flinty sand found a chemical union with the potash or soda of the clay; this vitreous connection fixed the sand firmly to the surface of the brick. Secondly, in a building, the lime attached itself securely to the sand, which was already fastened to the brick, in the same manner that good sharp siliceous sand, mixed with a certain quantity of quick-lime, after a lengthened period, would become hard, solid mortar. As far as the material alone was concerned, there was but little difference between tiles and bricks; the former were not generally manufactured with a sprinkling of sand externally, and it was well known that a pan-tiled roof could not be permanently pointed with mortar. After two or three years the pointing fell out, separating completely from the tiles, leaving them almost as free from mortar as if the process of pointing had never been performed. On this principle, verified by experiments, he (Mr. Smith) did not consider that any machine could make really good bricks, unless it had some fit and proper method of putting a sufficient quantity of good hard sand on the surface of the article while the clay was in a plastic state.

Mr. Frederick Lawrence remarked that Mr. Chamberlain's paper was apt to lead to the belief that London brick-makers generally had set their faces against machinery, and allowed machine bricks to be brought from a distance to London, rather than employ brick machines themselves. This was not the case, as in many brick-fields machinery was extensively used, and numerous steam-engines employed in the different processes of brick making—the clay in some instances being delivered by steam pug mills, in a prepared state, at the moulder's

bench. Moulding, however, was still done by hand; as an engineer, however, he knew how anxious brickmakers were to obtain a moulding-machine which would do its work constantly and well. They had heard from Mr. Clayton that he did not invent what he considered a perfect machine until six months ago; it was, therefore, only to be expected that brickmakers would hold back from adopting machinery until they were convinced it was of a perfect character and could be depended upon in all respects. Perhaps Mr. Chamberlain would inform them how long his machine had been at work, and whether it had been found practically to answer. Some brickmakers objected to all machines where the bricks were pressed through dies, because the bricks made by them were much heavier than those made by hand. A thousand of Mr. Chamberlain's bricks would weigh upwards of three tons, while ordinary hand-made bricks would not weigh two and a half tons; thus an addition of 20 per cent. in material and cartage would arise in machine-made bricks. These were serious items to be considered in the question of expense. Mr. Chamberlain's machine could only be worked just as fast as one boy could remove the bricks. An ordinary hand moulder could make bricks nearly as fast as a boy could carry them away, in fact, some moulders made as many as 8,000 to 10,000 per day.

Mr. Chas. May remarked, that he did not know whether it was intended that the discussion should embrace the consideration of machinery applied to brickmaking other than that now before them, but he thought it only right to glance at the very extensive use of machinery in the preparation of the clay in cases where no machinery was used for moulding. He knew that at Rutter's manufactory, down the Thames, they washed their clay so thin, that it was pumped up from 40 to 60 feet in depth, and carried along for a distance of a quarter to half a mile, into vats. In that one ground alone about 20,000,000 of bricks were annually made from this washed clay, and, he believed, they were now sold at 25s. per thousand, delivered on the Thames. They were, perhaps, the finest stock bricks in the neighbourhood of London.

Mr. Norton remarked, that it had been stated that rollers were the only method of making a well-formed brick. Mention had been made by Mr. Chamberlain of the perfect success of Heritage's water-die. He would add his testimony to that statement, having witnessed the operation of the water die, and he believed the bricks were manufactured at one-tenth less expense than was the case with regard to the specimens of bricks now before them. He thought Heritage's system was quite equal to any other in forming a perfect brick.

Mr. W. Dennis said—Having had some years' experience in brickmaking, as well as building, he might be permitted to say that he had never yet seen a brickmaking machine that would make bricks from the surface clay or London loam, mixed as it had to be with ashes from the dust-yards of the metropolis, and that with merely sifting, without grinding, except through a pug-mill. He had seen machines with rotary moulds, both horizontal and vertical, but not one to succeed. He made one himself, with rising pistons, but it did not make good bricks; nor would those that expressed the clay through dies or moulding orifices, and cut off the brick by wires, as the mixture of ashes prevented a smooth, clean cut being made, and would not allow of the free action of the wires. It was not true that the London brickmakers were apathetic. He had known many of them to expend large sums in experimenting with the various patents, and yet all failed. Perhaps the machine by Mr. Clayton, of the Atlas works, had been the nearest approach for making bricks from the London surface clay. He knew the London blue or deep clay would make a good brick by machinery with a mixture of sand; and very good red bricks were made at Sydenham (perforated), but in consequence of their being red, most of the London architects objected to them, although they were perfectly vitrified. He admitted most willingly that the general run of London-made bricks were very bad, there being always a great many outside bricks, such as place, shuffs, &c.; but the inside best bricks, known as stocks, were sufficient for all ordinary purposes. Then there were a great many known as burrs, ill-shapen and irregular in thickness; consequently, the joints of mortar were not of even thickness, and, as a consequence, the bond of the work built with them could not be good. Of course, the best stock bricks were not equal to good machine-made bricks from the plastic clays. The worst sorts of London bricks were to be had very cheap, and were used upon buildings where there was no architect or surveyor. As to the desirability of good even-made bricks, there could not be two opinions. The machine now before the meeting, with many others equal, and in some respects superior to it, when set to work in the various plastic clays of this country, would effect a great improvement in brickwork generally. He believed it would be found that the London surface clay or loam would never accomplish that change, by machinery or otherwise.

Mr. Chamberlain said, in reply to the observations which had been made, he must beg to differ from Mr. Beart's remarks—that clays could be too finely ground. It might be the case with some class of fire-bricks, but he had always observed that the Stourbridge fire-bricks, which ranked first in the kingdom, were generally much more finely ground than those of other districts, and to this, in some respects, he imagined they owed their superiority. The blue bricks, from the works of Messrs. Heywood, were made from the marls on the table, and would not be of so close and even texture but from the marl being most thoroughly ground. The discussion of that evening had been restricted almost entirely to London brickmaking, and in these districts rollers were, he believed, but little used for the preparation of the clay; but he was still convinced that by their use there would be found a great economy in manufacture, and from the grinding the ashes, or breeze, with the clay, and minutely dividing it, a far superior brick would be produced. By the use of rollers so large a pug-mill was not required, and that was the reason why the pug-mill portion of his machine was smaller than usual. The clay was most minutely divided in its passage through the rollers, and then the pug-mill had merely to amalgamate and compress it, which it effected in a very superior manner. As to quantity—the machine before the meeting threw off the bricks as fast as they could be removed, and this was at the rate of from thirty to thirty-five per minute, with four-horse power. In the use of sand for coating clays, as recommended by Mr. Smith, he thought that gentleman had overlooked the bricks made by this class of machinery. The wire in cutting off the brick, left the flat or mortar joint rough, in proportion to the quality of the clay; and this rough mortar surface produced a face to which mortar or cement would adhere most firmly. He had worked a similar machine to the one before the meeting for the last two and a-half years, and during that time he had not had a single breakage, or any derangement of the machine, which producing a far superior brick to those hitherto made by hand, and in any desired quantity.

The Chairman said they were much indebted to Mr. Chamberlain for his paper. Mechanics had for a long time past turned their attention to the construction of machinery for the purposes of brick making. He thought they could not have a better sphere for the exercise of their ingenuity; for the labour of hand brick making was of the most servile kind, and was considered of so degrading a character that bondsmen and captives, in former ages, were employed in it. Therefore, the introduction of anything that would supplant that kind of labour, and allow a man to turn his attention to more ennobling objects, was deserving of the highest consideration. He begged to move that the thanks of the meeting be

given to Mr. Chamberlain for his interesting paper, which having been unanimously accorded,

The Secretary announced that there would be an Extra-ordinary Meeting on the evening of Wednesday next, the 11th inst., when a further paper by Mr. Humphrey Chamberlain, " On the Drying and Burning of Bricks," will be read. On this evening, Joseph Glynn, Esq., F.R.S., will preside.

DESCRIPTION OF A NEW ATMOMETER, OR EVAPOROMETER.

By Arthur Mitchell, A.M., M.D.

(Communicated by Colonel Sykes, F.R.S.)

That branch of climatology which has reference to the humidity of the atmosphere, is scarcely second in importance to the thermometric or barometric phenomena. Yet few climates, as regards this constituent, have received a full investigation. The hygrometer of Regnault or Daniell, or the wet and dry bulb thermometers, furnish us with information on one aspect of the question. But there are others, and to one of these the instrument I am about to describe has reference. It does not deal with the amount of vapour in the atmosphere, nor with its bearing to the point of saturation, but shows the amount of water which the atmosphere, whether calm or in motion, *does actually*, or rather *can actually*, take up or convert into vapour. The determination of the dew point does not determine this. An atmosphere in motion, nearer the point of saturation, will take up more water than one further removed from this point which is still. Like the rain-guage, then, the atmometer is a supplement to, and not a substitute for, the hygrometer.

The particular fact which it elicits is one both of interest and practical importance. This has long been felt and admitted, and various instruments have been invented for measuring the rate of evaporation. Dr. Buist, in his meteorological notes, gives the fullest account of them which I remember to have seen. They consist generally of a simple saucer, modified in various unimportant details, of known area, with a scale at the side to mark the height at which the fluid stands, or attached to a balance, by which the loss is from time to time ascertained.

Among some of the objections to these there are the interference of the falling of rain or dew, and the difficulty of determining the quantity evaporated when it is very small, and, as the consequence of this, the quantity carried off during short periods.

Having practically experienced these inconveniences, I was led to construct the instrument of which I subjoin a section, and which, I think, supplies in a great measure the desiderata.

It consists of an evaporating dish, the losses in which are supplied, as they occur, from a reservoir, whose area is ten times, or any other given number of times, less than that of the evaporating dish.

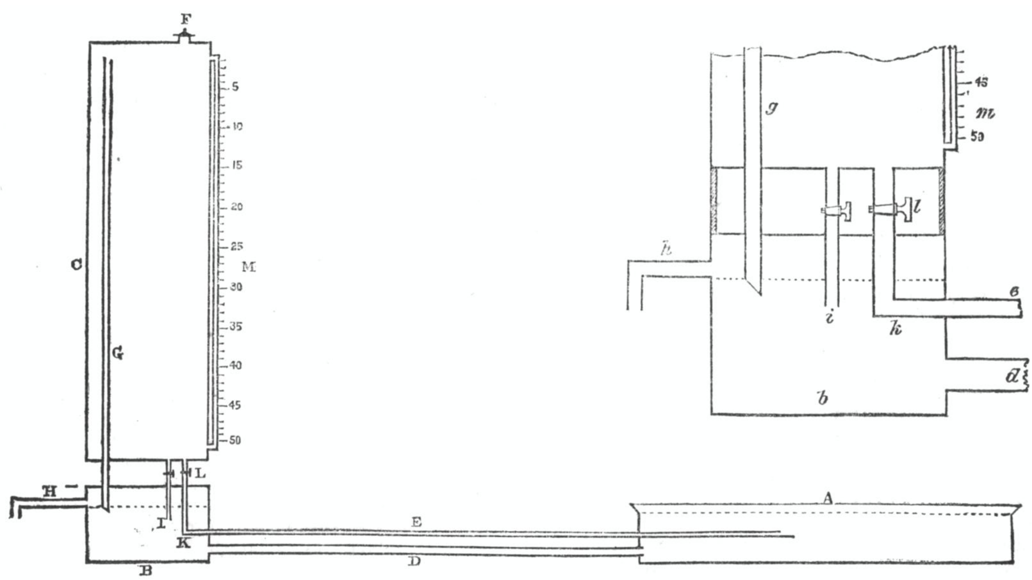
Its general principle is the same as that involved in the simple fountain inkstand, or the fountain drinking-cup of the bird's cage.

The details of its construction are best illustrated by the diagram.

The tube, D, connects the flat basin, A, to the smaller but deeper basin, B. Water will stand, therefore, at the same level in B as in A. Let us suppose both filled to the level of the dotted line.

The stop-cocks at L being then shut, let the cistern, C, be filled with water at the screw opening, F. If now the

Fig. 1.



cup is firmly screwed down, so as to make it air-tight, and the stop-cocks opened, it will be seen that the water will not flow out of the cistern till the level of the water in A and B is depressed.

This is clearly the case, for the tubes G, I, K, which communicate with its interior, have their openings below the water, and no air can enter. In fact, the cistern becomes the parallel of a jar standing in a pneumatic trough.

But suppose the level of the water in B to be lowered, then the mouth of the tube, G, which may or may not be carried up to the top of the cistern, admits air, and the displaced water flows out by I and K.

But the water which has thus escaped raises the level again, and so shuts the mouth of the tube, G, and then all remains stationary till a further depression of the level, when the same process is repeated.

A hydrostatic valve is thus obtained, simple, liable to no derangement, and acting with sufficient delicacy.

It will be observed that there are two outlet tubes (I and K), one of which opens into B, and the other into A. This is not essential, but its object is as follows:—When the whole escape takes place into the smaller basin, B, a trifling outflow raises the level temporarily and shuts the tube, G, but, as part of this flows into A, by the tube D, in order to adjust the level, as soon as it is spread over so large an area it practically becomes nil, and G is again opened, and so on, by small jerking escapes, till the equilibrium is established. To obviate this in some measure I have the two outlets, one of which, the larger, is prolonged directly into the evaporating dish itself. To be strictly accurate, the bore of the one tube should bear the same ratio to that of the other which the area of B does to A.

The motion of the water in A, caused by the wind, is not communicated through the long tube to B in any degree to interfere with the working of the instrument. Suspecting that this might be the case, I had devised a method of obviating it, but I found it unnecessary.

It is evident, then, that the water will always remain in A at the same level, that of the dotted line; for, as the water is carried off by evaporation, it is at once replaced by a supply from the cistern. This permanent or fixed level, to be acted on by the atmosphere, adds to the accuracy of the indication.

It is also clear that for every 1-10th of an inch evaporated, one inch will fall in the cistern, or otherwise if the areas are to each other in different proportions. This is read off on the glass tube which runs up the outside of the cistern, M; but, before taking the reading, it will always be well to place a cover for a minute over the evaporating basin, so that all the fluids may be at perfect rest.

But should rain or dew fall, and raise the level of the water in A, what will be the result?

That in B will proportionally rise, but the outlet of the tube, G, is exactly on the same level as the orifice of the tube, H, and by it, therefore, the water immediately flows away when it exceeds the level of the dotted line.

The instrument could thus be made to serve, at once, as a rain guage and an atmometer by connecting the tube, H, to some reservoir whose area bore a known proportion to that of A. In such a case, the lip of the atmometer would require to be somewhat differently constructed.*

Of course the instrument does not mark the evaporation which may occur while rain is actually falling, but this is so small an error as to be of no moment.

One of a rather more important character arises from the adhesion of the water to the sides of the tube, G, to overcome which, the level must actually fall slightly lower than the mouth of the tube before air is admitted. If, then, just before the break has taken place, a fall of rain occurs, a small portion of it would go to replace what had really been evaporated, and thus would entail an error. Again, the same adhesion of the water to the tube would influence the overflow by H. If a very small quantity of rain fell, it might raise the level actually above the level of H, but not sufficiently so as to overcome the capillarity and cause an escape. It would then remain and be carried off by evaporation without being indicated on the scale. These are both errors, but not grave ones. They can be overcome, however. It might be done by an arrangement of levers and balancings, producing a great difference of level in B, by a very small change in A. The complication, expense, and liability to derangement are the objections to this.

Another method of accomplishing the same end is simple, and without the faults of the preceding. It was suggested to me by my brother, Mr. James Mitchell. In it the tube H is connected with a pluviometer, as already pointed out, the whole apparatus being elevated about 3 feet above the general level around. The aperture of an ordinary pluviometer, identical in size with that of the evaporating basin, is placed at the same level, and as close together as may be deemed consistent with accuracy. It will be at once seen that the difference of the readings of the two pluviometers will show the error to be added or subtracted, as the case may be, to or from the reading of the evaporometer. The additional trouble will be slight, since one pluviometrical reading has at any rate to be taken.

Practically, I am of opinion that the error would be so small that it might be left without attention. But I have thought it right to point it out, and show how it may be corrected, by a method, too, which adapts itself perfectly to the exact nature of the error in each individual instrument, however modified in its mechanical arrangements.

The following sketch (see next page) exhibits the combination of the pluviometer and evaporometer, with the correcting pluviometer also attached, and some minor mechanical alterations which I owe to the same source.

Explanation of the Sketch.

A, B, is a stout post, fixed in a garden or other suitable place.

C, D, is another post, fixed at a convenient distance (say 6 feet), and in an open place, not overshadowed by trees.

The *evaporometer*, E, F, and the *pluviometer*, G, H, are attached by lugs to the cross arms of the post, C, D.

The cylindrical *reservoir*, I, J, of the evaporometer is attached by lugs with oblong slots to the post, A, B, and its level is delicately adjusted by the screw-bracket at J.

A *pneumatic well* is attached to the bottom of the *reservoir*, I, J, and the air-cock, *a*, the waste-cock, *b*, and the supply-cock, *c*, are shut and opened successively when the reservoir is replenished (by the air-tight cock at I), in such a manner as not to disturb the water-level in the evaporometer.

The water from the well is conveyed by the india rubber, gutta percha, or gas-pipe tube, *c,d,e,f*, to the evaporating dish, K, L, *which thus always contains water at the same level.*

When rain falls the evaporometer dish overflows by the small tube *at g into the subjacent cylinder*, M, N.

In order to prevent high winds causing an erroneous overflow by the tube at *g*, it is covered by a cap, which is one inch external diameter, and pierced with small holes in its lower edge, intended to admit of a gradual overflow from an actual rise of level in the dish, but prevent the action of waves raised by winds from being felt within the interior of the cup. An enlarged sketch of the cup and overflow tube is shown at O, P. It has a bottom with a hole in it to admit the small pipe, and a perforated diaphragm a quarter of an inch below the water-level, through which also the overflow tube passes. By these means the cap is retained firmly in its place. The top of the cap stands about 3-16ths of an inch above the water-level.

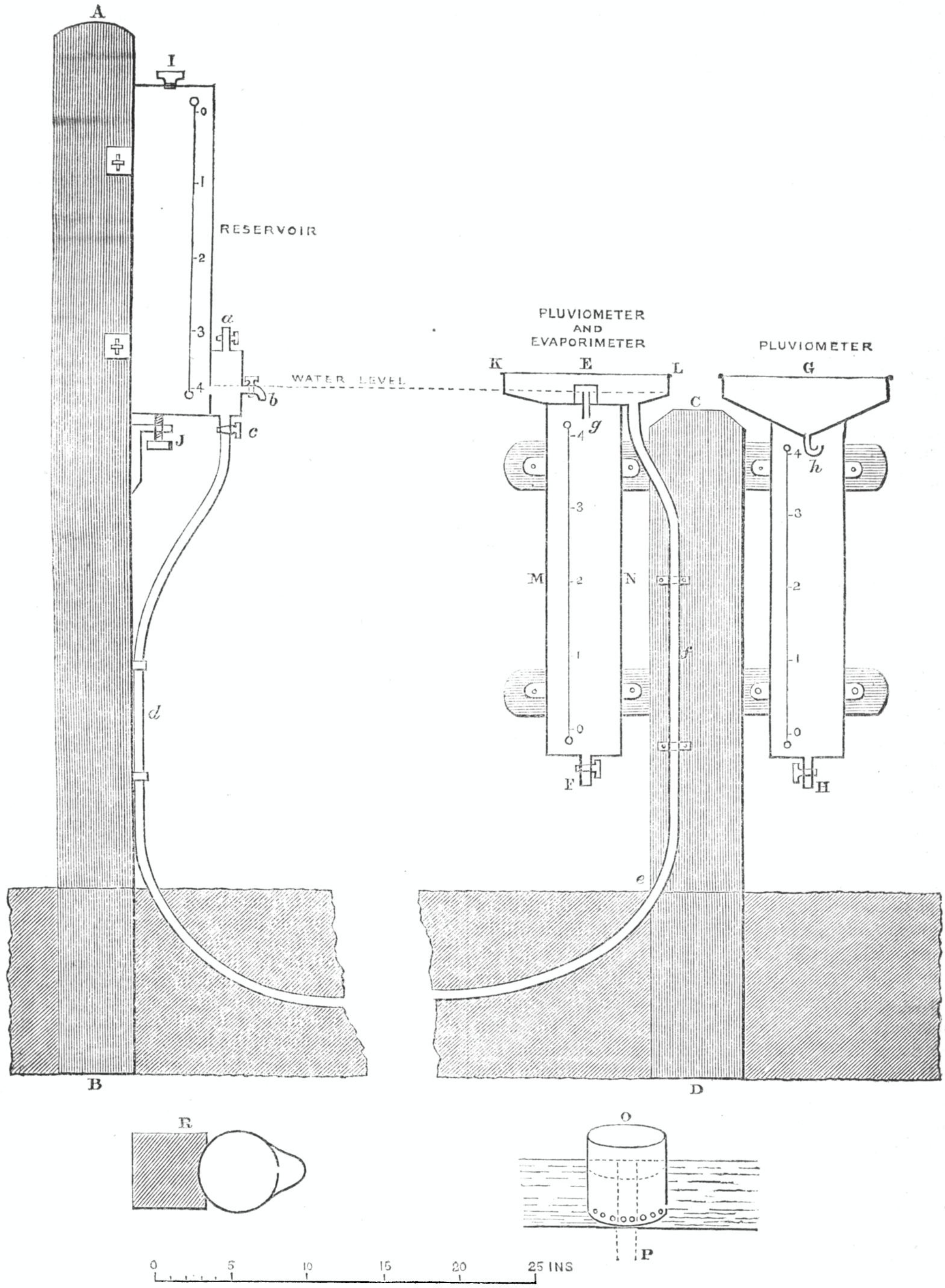
The reservoir of the evaporometer is 4·9 inches inside diameter, and the dish of the evaporometer 11 inches inside diameter, which, deducting for the cap (1 inch external diameter), makes the surface of the exposed water in the evaporating dish just five times the area of the interior of the reservoir, making every five inches in the small glass tubing scales represent one inch in the dish of the evaporometer.

The cylinder of the simple pluviometer, and also that of the combined pluviometer and evaporometer, are 4·92 inches inside diameter, both exposing an area of 11 inches diameter to the action of the falling rain. The cap in the evaporometer, standing in the centre of the dish, only 3-16ths of an inch above the water level, and more than half an inch below the level of the lip, will not prove an interfering cause.

R is a section of the reservoir through the water level. The pipe, *c d e f*, is to be carefully laid with a regular

* The instrument, as described below, is at present being constructed by Casella & Co., 23, Hatton-garden, and will be placed on the table for inspection at the next meeting of the Society.

Fig. 2.



rise on each side from the lowest point, so as to prevent the lodging (by disengagement) of air in any irregular bend.

The rain is admitted into the pluviometer cylinder by a small hydrostatic trap at h.

The overflow cylinder of the evaporometer is theoretically a pluviometer, but any difference found in practice between its indications and that of the pluviometer, will shew what corrections, if any, must be made on the indications of the evaporometer reservoir, in consequence of capillary attraction minutely affecting the operations of the water level, or in so far as the action of high winds may occasionally induce a slightly excessive overflow.

The dishes of the evaporometer and pluviometer need not be fastened to their subjacent cylinders, but may be

made easily removable, and fitting tightly only by a faucit and socket-joint.

The waste-cocks at *b*, F, and H, are useful for adjusting levels before commencing a series of observations.

The whole of the apparatus, except the post, cocks, and tubing, may be made of tinned iron or zinc, and of cheap and easy workmanship, having wires inserted by a common process in the open edges of dishes and cylinders to keep them stiff and circular. It might be constructed so that the cylinders would go into one another, like a nest of pill-boxes, so that the whole might be packed up in a small volume for carriage to any place, where a post could easily be found on which to erect it.

The post, A, B, might be dispensed with, and the reservoir mounted on a slender perpendicular continuation of the post, C, D. This, in some winds, would bring one or other of the dishes too much under lee of the reservoir, but (by lengthening the cross arms of C D so as to admit of the cylinders being set more apart) it is probable that the error so induced might be reduced to a very trifling amount, and the instrument would be rendered more unique and compact, and sufficiently, though not quite so free of error, as by the plan of keeping the reservoir at a greater distance.

By the following formulæ an area may be reduced or augmented by any given number of times—

$$D = \sqrt{d^2 n} \text{ and } d = \sqrt{\frac{D^2}{n}}$$

MEANS OF ARRESTING FIRES.

Mr. D. J. Murphy, of the Cork Chamber of Commerce, in a letter to the Secretary, describes a plan for arresting fires, which he submitted to the Board of Admiralty above a dozen years since.

The process proposed is stated by the author to be simple and effectual, and not to interfere much with the machinery employed at present.

"It is simply saturating the water discharged from fire-engines with a certain proportion of chloride of sodium (common salt) and potash, both cheap articles; and, indeed, the former alone will be found quite effectual in all ordinary cases. The proportion of these ingredients to be employed may vary from one-tenth to one-thirtieth of the weight of the water so discharged, of which it will be found that a considerably less quantity shall be required, from being so saturated. In low elevations, and where the flame has not reached a great height, the stronger impregnation may be used with advantage; but when the flame has arrived at a considerable elevation, the weaker impregnation can only be employed, arising from the greater resistance of the air, the increased weight of the materials, and the augmented difficulty of the stronger impregnation passing through the valves of the fire-engine; though, even then, it can be successfully discharged to attack the flame at its root or base, which is, perhaps, the best course to adopt in all cases. A fireman, in his ordinary dress, and simply armed with an elastic tube conveying this stronger impregnation, may boldly and securely face the strongest and fiercest flame, and make himself a passage through it, by commencing cautiously at first to discharge the impregnation on each side of him; for, where it falls, it not only subdues the flame, but, by leaving a coating of the materials, it prevents it from readily catching again the substance on which it previously fed; the result being, that the muriatic acid becomes volatilised, and flies off, while the soda, which is indestructible, is converted into a glaze on the surface. The root or base of the flame is therefore the point to which the force, power, and efficacy of the impregnation ought always to be directed.

"This impregnation, it is to be observed, can be so managed, by the addition of other ingredients, when found necessary, or where the expense is disregarded, such as the diluted mineral acids and their salts, as to produce a temperature approaching, and even considerably below, the freezing point on Fahrenheit's scale, and yet preserve its fluidity; for it is by its chemical combination it acts against the flame, and also in serving to reduce the temperature of the surrounding heated atmosphere. The effect of several engines acting at the same time, by the weaker and stronger impregnations, must be all powerful, as may be easily conceived; and no fire, whatever degree of head it may have previously attained, can resist the power and efficacy of this impregnation for any period exceeding half an hour. Even water, saturated with finely powdered clay, chalk, slacked lime, &c., all cheap articles, and slow conductors of heat, may be employed with great advantage on flames of low elevation; for it is to be impressed that water is alone used as a medium for conveying these substances, as well as the others, to the body of the flame, or rather to its source—such as the substance on which it feeds. Let this be completely coated with those ingredients; for the water will be quickly evaporated by the intense heat, and the effect sought—namely, the extinction of the fire—will be the immediate and necessary consequence. * * * * *

"If the increased expense of the new plan be estimated, it will be found insignificant, compared with the benefits it will confer, and the innumerable evils and calamities which will be prevented. Taking the average of the quantity of the ingredients required as forming one to twenty of the weight of water, it would amount to about 400lbs. weight of salt and potash to saturate sufficiently, say 800 gallons of water; and the estimated cost of these ingredients would not much exceed twenty shillings, an expense no insurance company would withhold, with the certainty of saving from destruction perhaps some thousands of pounds, and probably the lives of a few human beings. But this is the very highest estimate of cost, for from some small experiments made by the proposer of the plan, he found with only 4.10 parts of common salt to 95.90 of water, which reduced the temperature to 27.8 on Fahrenheit's scale, fully three degrees below the freezing point, that even this slight impregnation was discovered to be sufficiently effectual, and produced a surprising effect. The proportion is, however, always to be regulated, not so much by the height of the flame, as by the height of its source, or the materials on which it feeds. This is generally not higher than the 1st, 2nd, or 3rd floor of a dwelling house, and the proportion of the specified ingredients may be regulated accordingly. But, taking the quantity as before, above 100lb. weight of salt will thus be conveyed and spread over each floor of the house.

The same principle, which it is evident solely depends on the efficacy of the impregnation, may be carried into effect in subduing and dissipating the foul and inflammable air which is sometimes generated in the old workings of coal and other mines, and which so frequently leads to the destruction of many lives. Any necessary strength can be given in this case to the impregnation, and it will have the same beneficial result by purifying and neutralising the baneful effects of this fatal and inflammable gas, for which purpose it will be requisite to employ a small garden-engine to saturate those places where Davy's lamp indicates the existence of this destructive gas."

The author also states—

"That he considers it is possible to extinguish fires, more especially at the commencement, and of low elevation, without the employment of either water or fire-engines, merely by discharging, by means of a simple machine, finely-powdered clay, lime, chalk, &c., assisted by the air, through a tube, on the blaze or flame."

ON THE PURIFICATION OF POLLUTED STREAMS.

By F. Crace Calvert, F.C.S., &c.

In consequence of the interesting paper read by Professor Clark, M.D., before the Society's Ordinary Meeting of the 14th of May, "On Means available to the Metropolis and other places for the supply of water free from hardness and from organic impurity," I beg to forward you the following remarks, which I hope will prove interesting to the members of our Society. It will furnish another important instance of the value of lime for the purification of water as first established by Professor Clark, and subsequently applied by Messrs. Higg and Wicksteed to sewerage waters. They will be found to contain some information respecting the remarks made at the meeting by the chairman and by the Rev. J. C. Clutterbuck, respecting the removal of organic matter in solution from polluted water.

Having often reflected on the source of diseases generated by the effluvia from the highly polluted streams which pass through most of our manufacturing and densely populated towns, as was exemplified in Manchester, in the neighbourhood of the river Medlock, during the visitation of the cholera in the years 1832, 1849, and 1854, I thought it my duty to draw the attention of the Sanitary Association of that city to the importance of trying to find out means of decreasing or removing the above source of public nuisance. At their request I began, during the autumn of 1854, a series of experiments, the results of which I have laid before them in two reports.

I am induced to publish some of the facts contained in these reports, as they are, to the best of my knowledge, *the first* which have been obtained in experiments on a large scale with a view to removing *organic matter in solution and suspension in a running stream similar to the Medlock;* for the experiments made by Messrs. Higg and Wicksteed, and Professor Clark and Mr. John Graham, on this subject, have especial reference to the removal of these substances from water when confined in reservoirs, or settling lodges, and not in a constant moving mass of water such as the Medlock, on which I operated.

I shall arrange my remarks under four distinct heads, viz.:—

I.—Laboratory Experiments.

Having procured some of the black and fœtid water which is constantly flowing down the Medlock, I added to separate portions various chemical substances, and found that lime, as proposed by the above-named gentlemen, or the disinfecting powder of Dr. Angus Smith and Mr. McDougall, was the cheapest and best material that I could employ; for, when lime is added to the water, it combines with the organic matter and the excess of carbonic acid in solution in the water, and the flocculent precipitate thus produced falls rapidly to the bottom of the vessels in which the experiment is made, leaving a clear transparent fluid.

I further remarked, that the odour had nearly disappeared, which is a matter of high consideration, as the quantity of gases produced by the putrefaction of the organic matter deposited in the stream, is enormous; and, although these gases may not be the real source of disease, still they accompany the miasmata which are the direct cause of injury, and are, probably, the means employed by nature to warn man of the presence of danger. I may here state, that afterwards, when the process was carried out on a large scale, the same effects were obtained.

After many trials, I found that two or three grains of hydrate of lime per gallon were quite sufficient to produce the above results.

II.—Composition of the Water of the River Medlock, and the Action of Lime in Purifying the Same.

Before describing the chemical action of the lime on the substances in solution and suspension in the river Medlock, it is necessary that I should give the composition of the water which was operated upon on a large scale.

Composition of the Water of the River Medlock, taken above Manchester, and before it has been polluted to any extent, as compared with the same water when it has passed through the town.

	Before passing through the town.	After passing.
Organic matter per gallon	4.20	8.40
Mineral do.	36.75	32.90
	40.95	41.30
Salts of Lime:		
Chloride	none	none
Sulphate	very abundant	very abundant
Carbonate	exceedingly abundant	exceedingly abundant
Salts of Magnesia:		
Chloride	rather abundant	rather abundant
Sulphate	exceedingly abundant	exceedingly abundant
Carbonate	very small quantity	small quantity
Salts of Potash:		
Chloride	small quantity	large quantity
Sulphate	rather abundant	rather abundant
Salts of Soda:		
Chloride	rather abundant	rather abundant
Sulphate	very abundant	very abundant
Salts of Ammonia:		
Nitrate	traces	traces
Carbonate	traces	traces
Salt of Iron:		
Carbonate	abundant	very abundant
Phosphoric Acid	traces	traces
Silica	traces	traces

The difference in the amount of mineral matter is doubtless due to the water having been taken at different times.

The only point of interest in the above analysis is the remarkable fact that this water contains a large amount of sulphate of magnesia, the presence of which salt I have constantly met with in the numerous Lancashire waters which I have analysed.

But, with reference to the nature of the water which I intended to operate upon, I thought it advisable to take samples from the river during several days, and to ascertain the quantity of matter in suspension, the quantity of organic matter in solution, and the quantity of mineral matter per gallon; and the following are the results obtained:—

Table No. 1.

No. of Experiment.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Grains in suspension per gallon	5.62	6.18	6.40	6.70	8.36

I found the above quantities to consist of—

Organic matter	53.69 per cent.
Inorganic	56.31
	100.00

The quantity of matter in solution was represented by:—

Table No. 2.

No. of Experiment.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Organic matter per gallon	8.40	6.65	7.35	10.85	9.45
Inorganic ditto	32.90	20.30	21.35	20.65	22.75
	41.30	26.95	28.70	31.50	32.20

These figures clearly show the large proportion of organic matter which the water contains in suspension and solution, and give a clear insight into the source of the

noxious effluxia which the river is constantly emitting; but what renders these figures especially interesting, is, that they enable me to show the exact action of Lime when applied to such waters, as shown by the following Table:—

Table No. 3.

Composition of the water of the Medlock after treatment with Lime—

No. of Experiment.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Organic matter per gallon	3.5	2.8	4.2	3.5	3.5
Inorganic ditto	26.6	25.2	22.4	15.4	21.7
	30.1	28.0	26.6	18.9	25.2

It is chiefly in comparing this table with No. 2, that the value of lime in purifying the water of the Medlock is clearly demonstrated; for it does not only remove the dirty black matter in suspension, and consequently clarify the water, but it also removes the greater part of the organic matter in solution, for we find that if we take the total average amount of organic matter in suspension and solution, as 12.11 [qy. 8.54] grains per gallon before applying the process, there remains, after the application of the lime on a large scale, and directly added to the river, only 3.5 grains per gallon of organic matter; or, in fact, a quantity less than exists in many river waters which are used for domestic purposes; but I do not mean to state that this water could be used as a human beverage, for it gave, on evaporation, a nitrogenated residue. I also analysed the deposit produced by the action of lime in the running stream, wishing to ascertain if such a deposit would be sufficiently rich to prove a valuable manure, and thus tend to diminish the expenses attending the application of the process, but it will be perceived, by examining the figures in the following table, that its value is comparatively small, and that it could only be applied to certain kinds of land, and in the immediate vicinity of the stream:—

Table No. 4.

		No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Organic matter	Vegetable	22.01	20.47	18.07	17.17	19.81
	Animal...	4.89	4.73	4.89	5.15	5.59
Phosphoric Acid	....	.56	.60	.68	.68	.56
Matter insoluble in Acid.	Silica abund. Sulph. of Lime very small quantity......	10.98	7.76	8.80	9.76	11.04
Matter soluble in Acid.	Carbonate of Lime, exceedingly abundant Carbonate of Magnesia small quantity. Oxide of Iron abundant. Alumina traces Manganese traces.	61.56	66.44	67.56	67.24	63.00
		100.00	100.00	100.00	100.00	100.00

I have analysed the manure sold in bricks at Leicester, and produced by addding lime to the sewerage water of that town by Messrs. Higg and Wicksteed, and find it to have a very similar composition, viz.,

Organic matter	16.89
Water	3.91
Lime................................	32.52
Magnesia	1.52
Iron and alumina	8.90
Carbonic acid	24·46
Silica	11·82
Sulphuric acid....................	·24
	100·26

I also analysed the natural deposit which is constantly forming in the River Medlock, and, to my astonishment, found that it was still poorer in organic matter, as will be seen in the following analysis. This is no doubt due to the fermentation and putrefaction which are constantly going on in the deposited mass.

	Organic matter	13·600
Soluble in water	Sulphate of lime	1·006
	Do. potash	·800
	Chloride of magnesium... Do. sodium.........	·544
	Silica	1·000
Soluble in acid	Phosphoric acid	·200
	Peroxide of iron	4·020
	Alumina	4·530
	Carbonate of lime	8·250
	Sand	66·050
		100·000

It is possible that the presence of phosphates, which is noticed in this deposit, is due to a certain amount of sewerage water which the river receives during its course through the town.

III.—Method which was Adopted to Apply the Process.

Before applying on the whole of the Medlock, the process which will be hereafter described, it was thought advisable to only purify a portion of the water which was necessary to supply the Bridgewater Canal, and to effect this the following apparatus was devised by C. E. Cayley, Esq., C.E., and constructed at the expense, and under the superintendence, of the Bridgewater Trust.

1st. The water of the Medlock is admitted into the canal at Knott-mill, and passes underneath two archways, and thence along two basins—the basins being continuations of those formed by the archways.

2nd. The quantity of water so admitted is regulated by permanent sluice-gates, placed across the stream at the higher end of the archways; the water not required passing away through an overflow basin into a tunnel, which conveys it into the river at a point lower down.

3rd. The larger of these basins under the archway and warehouse was employed for the experiments.

4th. The construction of the apparatus was as follows:—

I. Two wooden vats, each thirteen feet square and three feet ten inches deep were placed over the overflow, and near the side of the river. In the vats the lime was mixed with water.

II. From each of these vats the solution of lime was discharged at pleasure into a trough, having a perforated bottom, and which extended across the Medlock at an elevation of several feet above the water.

III. About 12 feet higher up the river than the permanent sluices, a dam was constructed above the stream, forming a weir, over which the water had to flow into the depositing basin, and was so placed that the solution of lime falling from the perforated trough mingled with the river water as it passed over the dam.

IV. To regulate the quantity of water operated upon, a series of slides was fixed along the top of the dam, which could be raised or depressed at pleasure.

V. At the opposite end of the basin another dam was fixed across the canal, the top of which was about eight inches below the top of the dam in the Medlock.

VI. The space between the two dams thus became a separate basin, about 142 feet long, 27 feet wide, and 8 to 10 feet deep, divided into two compartments of very unequal size by the permament sluice gates.

VII. The water, therefore, passed over the upper dam, where it received the lime into the small compartment, whence it passed underneath the permanent sluice gates into the larger one.

5th. The isolation of the depositing basin was, however,

rendered imperfect: firstly, by the managers of the canal letting the river water into the smaller compartment at times when the experiments were suspended, for the purpose of supplying a water wheel; and secondly, by the contents of a sewer entering beneath the warehouse.

Before giving some of the results arrived at, and also to explain the difference between the results of laboratory experiments and those actually obtained at the river, it is necessary to state that the above apparatus, being only a temporary one, was far from perfect in its construction, and that consequently a large quantity of non-precipitated water was constantly running into the reservoir, and thus rendered the experiments less conclusive than they would otherwise have been. The two following experiments are taken out of a series:—

	Height of the Water as it passed over the Weir.
No. 7. 10 cwt. of lime put in the mixing tank, Began at 11·0, stopped at 3·15. Guage all the time. Water used to mix lime, 6,620 gallons. Water purified, 467,606 gallons.	2 $1\frac{5}{8}$ $1\frac{5}{8}$ $1\frac{1}{4}$
No. 9. 10 cwt. of lime put in the mixing tank. Began at 8·45, stopped at 1·10. Guage all the time. Amount of water used to mix the lime, 5,178 gallons. Water purified, 485,944 gallons.	2 $1\frac{5}{8}$ $1\frac{5}{8}$ $1\frac{1}{4}$

Therefore, from these results it is clearly seen that, with ten cwt. of lime, about 500,000 gallons of water were purified; and there is no doubt, in my mind, that if the mixing of the lime with the water had been more perfect, and the lime had had more time to act, as would be the case were the plan adopted on the whole stream, a much greater quantity of water could be purified; in fact, there is no reason why the quantity of lime, viz; two or three grains per gallon, which was found sufficient in the above-cited laboratory experiments, should not prove equally efficient when applied to the whole stream; and if this conclusion were to prove correct, then the following general deductions could be considered as proved, viz., that it would require only about three cwt. of lime to purify 1,000,000 gallons of water of the river Medlock, and if this were the case, as it is estimated, that the average flow of the river Medlock is about 16,000,000 gallons per day, the quantity of lime required to purify and deodorize it to a practical extent would be about $2\frac{1}{2}$ tons of lime per day; which, considering the benefit it would confer on the inhabitants at large, cannot be considered as an expensive and impracticable process. It must be borne in mind that this plan could be more easily applied to small streams of a similar nature, which flow through such towns as Bolton, Oldham, &c.

There is also another consideration which should have weight with the inhabitants of such towns, viz., that this mode of purifying water similar to that of the Medlock, would prove of great advantage to manufacturers who use it to supply their boilers, for the amount of mineral matter, as shewn in tables, Nos. 2 and 3, remains nearly the same; and, consequently, the lime process does not increase the amount of mineral matter in the water; and if the composition of the deposit thrown down by the lime be considered, the advantage of the lime process becomes evident, for I find in the deposit (see table No. 4) three substances, viz., organic matter in large quantities, oxide of iron in large quantities, and sulphate of lime, which three matters are liable to prove most destructive to boilers; whilst water merely containing a little lime will not prove injurious, and any chance of incrustation would be prevented by adding to the water supplying the boilers a small quantity of sal-ammoniac, as recommended by Dr. Ritterbandt.

IV.—METHOD PROPOSED FOR APPLYING THE LIME PROCESS ALONG THE COURSE OF A STREAM.

The plan which I propose consists in taking advantage of a general law which water presents when running in a stream, viz., that the matter in suspension carried by such waters is deposited near the angles and curves, and within the still-water line of the stream, which is always opposed to the larger or external curve, and in having small reservoirs, the size and position of the natural deposit beds within the still-water line, so that when the natural matters in suspension, or those produced by the lime, flow down the stream they will naturally settle in these tanks, and as those tanks would be numerous along the course of the stream, the deposit which might escape one tank would probably, in a great measure, be gathered by the second. The efficiency of these tanks would be increased by the application of the lime process, owing to the fact that the curdy precipitate produced by this substance in such waters, separates, and falls with extraordinary rapidity, for it was remarked in the course of my experiments, that immediately on the addition of the lime the water was decolourised, and that it became transparent in a few minutes, whilst the natural water does not become clear until after standing several days.

To apply the lime I would propose that at several hundred yards above curves the best adapted for establishing the above-mentioned subsiding tanks, barriers should be thrown across the stream, with openings, so as to retain the lime without materially impeding the flow of the water. Behind these barriers I would place a layer of lime, the thickness and renewal of which would be regulated according to the flow of the stream. The matter in suspension in the water, so coming in contact with the lime, would be carried down and deposited in the still-water line, or in subsiding tanks occupying its position.

Home Correspondence.

REMARKS ON PROFESSOR CLARK'S PAPER ON THE SUPPLY OF WATER FREE FROM HARDNESS AND FROM ORGANIC IMPURITY.

SIR,—I find by your *Journal* of the 23rd instant, that Mr. Dugald Campbell has impugned the accuracy of the analyses of different waters submitted by me to the Society of Arts, and also takes objection to the conclusions I deduced therefrom.

I do not propose to quarrel with Mr. Dugald Campbell for the tone he has adopted, because the discussion of a question of science ought not to be encumbered with personalities. I shall therefore confine myself simply to explanation, to facilitate which I propose to divide the fifteen examples I submitted into five compartments of three each.

The Table of Analyses complained of by Mr. Dugald Campbell contains fifteen examples, thirteen of which were published *six years ago*, in a table, with my evidence, in the Report by the General Board of Health, May, 1850; the remaining two examples, newly introduced, are the analyses of Mr. D. Campbell and the statement of Dr. Clark. Further, of the whole fifteen examples, twelve are from the "so-called chalk water," and of the twelve four are from the same well in Trafalgar-square. The remaining three examples are from so-called pump spring water, and which were introduced, be it remembered, *six years ago*, for the purpose of drawing the attention of the honourable members of the Board of Health to the large predominance of the carbonate and sulphate of lime in what was then and is still considered to be "*pure spring water*."

As the accuracy of thirteen of the examples of the fifteen had not been questioned by Mr. D. Campbell, or any other chemist, for a period of *six years*, I think I had a right to reproduce them as correct, but as Mr. Campbell now objects, I submit the following explanation:—

On reference to the table I presented to the Society of Arts, it will be seen that the first three analyses in the first

compartment are stated to have been made by Professor Graham, in 1844 (fourteen years ago), and were then ordered by the Commissioners of Greenwich Hospital through me. I have before me a copy of Professor Graham's report with the analyses of the three waters, which is as follows:—

"The waters of the three wells is decidedly hard for deep wells in which the water comes from below the deep clays, being harder, by one-half at least, than Thames water, &c.

"Several of the deep wells about London, which I have had the opportunity of examining, are softer than Thames water, and the only reason I can give for it is—their greater depth than the Greenwich."

(Signed) "Thomas Graham."

Statement of the analyses, as published by Mr. Braithwaite, to the General Board of Health.			Analyses of Three Chalk Waters, by Professor Graham, in 1844.	Statement of the analyses in Mr. Braithwaite's Table, Society of Arts Journal, May 16, 1856.		
Greenwich Brewery.	Page's, Greenwich.	Lambert's, Deptford.		Greenwich Brewery.	Page's Brewery.	Lambert's, Deptford.
Grains	Grains	Grains		Grains	Grains	Grains
19·08	21·23	16·74	... Carbonate of Lime ...	19·08	21·23	16.74
0·52	nil.	nil.	... Carbonate of Iron ...	nil.	nil.	nil.
nil.	nil.	0·80	...Carbonate of Magnesia...	nil.	nil.	0·84
2·04	2·88	2·75	...Sulphate of Magnesia...	2·04	2·88	2·75
3·62	0·62	2·67	......Sulphate of Soda......	3·62	0.60	2·67
0·37	3·12	1·91	... Chloride of Sodium..	0·37	3·12	1·91
1·67	nil.	1·33	.... Loss	1·67	nil.	1 33
27·30	27·83	26·24	.... Total	27·30	27·83	26·24

The only error in the above three analyses is the omission of the carbonate of iron in the Greenwich well water, viz., 0.52 grains in the gallon, and which, if added to the column or table submitted to the Society in 1856 will make that addition correct.

The second compartment in the table consists of three analyses made by Mr. Brande in 1846, now ten years ago, and, as before stated, were published by me six years ago. I took these analyses from published documents. On reference to the water of Trafalgar-square, in my table of 1856, I find the solid contents are stated at 66.1 grains to the gallon, there being 59.9 grains of soda salts, 3.1 grains of carbonate of lime, 2.4 grains of carbonate of magnesia, and 0.7 grains of silica. The accuracy of this analysis is confirmed by Mr. Dugald Campbell himself, for I find in his printed Report on the Source, &c., page 2, line 23, the following:—

"According to Mr. Brande, in 1846, the solid contents per gallon were 66.1 grains, consisting of 59.9 grains of soda salts, 3.1 grains of carbonate of lime, and 2.4 grains of carbonate of magnesia." This gives as under:—

Mr. Braithwaite's Table, 1856.	Trafalgar-square Well Water, by D. Campbell.	Mr. Campbell in 1856.
Grains.		Grains.
3.1	......Carbonate of Lime......	3.1
14.6	......Carbonate of Soda	59.9
19.6	.... Sulphate of Soda	
25.7	......Chloride of Soda	
2.4	...Carbonate of Magnesia ...	2.4
0.7	.... Silica	
66.1	...Total solid contents per gal....	65.4
	Silica, omitted by Campbell...	0.7
		66.1

I have compared the other two analyses of Mr. Brande, and I find they agree with those published by me in 1850, and I cannot find any discrepancy.

The three analyses in the third compartment are those made by Mr. Phillips, by order of the Directors of the North Western Railway, in 1849, and submitted to the Institution of Civil Engineers by one of the officers of that Company, I think Mr. Dockray. The object of that paper was to induce an explanation of the singular phenomenon that of three analyses of chalk water (Watford, Tring, and Camden-town), two (Watford and Tring) should hold 19.54 grains and 14.72 grains respectively of carbonate of lime, and only 1.98 grains and 1.38 grains of soda salts to the gallon, while in the third (Camden-town) no carbonate of lime could be found, but 41.70 grains of soda salts to the gallon.

Referring to the paper so presented, I find I have correctly given the analysis as therein submitted, and which is as follows:—

As presented to the Institution of Civil Engineers.			Analyses of three Chalk Waters, by Professor Phillips.	As presented by Mr. Braithwaite to Society of Arts.		
Camden Town.	Watford.	Tring.		Camden Town.	Watford.	Tring.
Grains	Grains	Grains		Grains	Grains	Grains
nil.	19.54	14.72	... Carbonate of Lime ...	nil.	19.54	14.72
17.60	,,	,,	... Carbonate of Soda ...	17.60	,,	,,
13.00	,,	,,	......Sulphate of Soda......	13.00	,,	,,
	0.94	1.09	......Sulphate of Lime......		0.94	1.09
11.10	1.90	1.38	... Chloride of Sodium ...	11.10	1.90	1.38
2.30	1.32	1.61	...Carbonaceous Matter...	2.30	1.32	1.61
44.00	23.70	18.80	.... Total	44.00	23.70	18.80

The fourth compartment of the Table is of three analyses of pump spring waters; that of the Treasury pump was taken from the published analyses of Dr. Bostock; the two from the wells at Roehampton were made for me by Mr. Beale, of Long Acre, in 1841, and were published by me six years ago, and for the purpose before stated. I cannot trace any inaccuracy in these hard—very hard-waters, there being in the Treasury pump-water 50.4 grains, in the Roehampton pump 88· grains, and 48 grains of *Salts of Lime* to the gallon.

The fifth and last compartment of the table consists of—1st, the analysis of Mr. Dugald Campbell; 2nd, the statement by Dr. Clark of the solid contents of a gallon; and the 3rd, the analysis of the College of Chemistry, all on and concerning the Trafalgar-square well water.

1st, As to Mr. Dugald Campbell and his analysis, I wish to invite particular attention.

At a discussion on a paper, prepared by me, of this very water question, for the Institution of Civil Engineers, in the session of 1855, Mr. Dugald Campbell differed then, as he now does, with me, in opinion, particularly as to his then omission of the 13.67 grains of sulphate of *potash* to the gallon, in the analysis of the College of Chemistry (Messrs. Abel and Rowney) of the Trafalgar-square well water. Being very desirous of a friendly explanation, I wrote courteously to Mr. Dugald Campbell, to inquire why he had omitted these potash salts, to which I received as courteous a reply, in which he observed—"I do not think it would benefit either of us entering into a correspondence which would likely be very lengthy, on the subject of your paper." I now very much regret that Mr. Campbell declined to meet me, because it is more than probable that, by mutual and friendly explanation, we should have avoided the present complications.

To proceed with Mr. Campbell's analysis. In April last, I was favoured by that gentleman with a report of his paper to the Chemical Society "On the Source of the Deep Wells under London," in which he gives a recent

analysis of the Trafalgar-square well, made by him. I now place it in juxtaposition with the analysis in my table:

Statement in Mr. Campbell's printed Report.	D. Campbell's Analysis of the Trafalgar Square well water.	Statement in Mr. Braithwaite's Table.
Grains.		Grains.
10.58	...... Carbonate of Soda	10.58
21.34	...... Sulphate of Soda	21.34
19.04	...... Chloride of Sodium	19.04
1.05	......Carbonate of Potash	1.05
2.07	... Carbonate of Magnesia ...	2.07
2.74	...... Carbonate of Lime	2.74
0.97	...Phosphate of Iron & Lime...	0.97
0.40	.... Silica	0.40
0.66	...... Volatilized Matter	0.66
58.85	.... Total	58.85

One more reference to Mr. Dugald Campbell's letter and report. In the concluding part of *this letter*, Mr. Campbell invites me to an analysis of the several waters, observing, "I am sure that if Mr. Braithwaite would experiment himself, instead of culling portions of analyses here and there, and speculating upon them when reduced to a tabulated form, without *any data* of how they are obtained, he himself would neither differ so widely from chemists as he now does, nor would he find chemists to differ as widely from themselves as he states."

In Mr. Dugald Campbell's published report of his paper to the Chemical Society, 1856, page 3, commencing line 15, will be found the following, as a specimen of the *entente cordiale*. He modestly commences:—"Perhaps I may be allowed a digression here to state, that before this I had analysed the water from many of the deep wells in different parts of London, and in *all* I found a *large* amount of *soda salts*, and a *small*, though weighable quantity, of *potash salts*, varying in potash (carbonate) from 0·327 grains in a gallon to *as much* as 1·33 grains, but *I was scarcely prepared* to find the Trafalgar-square water to have the same character, Messrs. Abel and Rowney (College of Chemistry) having found 13·67 grains of *sulphate of potash* to the gallon. However, on procuring a copy of the Minutes of Proceedings of the Civil Engineers, vol. ix., I, *for the first time*, saw Mr. Brunel's analysis, and either he had not detected *any* potash salts in the water, or they were in such small quantities as not to be considered by him worth noticing, for they are not given in the analysis."

And now as to Dr. Clark's statement of the quantity of solid contents in one gallon of the Trafalgar-square water, namely, 79½ grains.

In January, 1855, I was invited to take part in the discussion on Mr. Homersham's paper, "On the Chalk Strata Considered as a Source for the Supply of Water to the Metropolis." I was not aware that Dr. Clark was in the room. In the observations I then made, more in reference to quantity than quality, I incidentally mentioned the large quantity of *sea salts* in the deep well waters. The Rev. Mr. Clutterbuck followed me, when Dr. Clark took both the Rev. Mr. Clutterbuck and myself very roundly, and, as I thought, not very courteously, to task; I presume for daring, as non-professionals, to offer any opinions as to the chemical condition of deep well waters.

Dr. Clark, in contradiction to me, stated, "that he had a friend sitting near him who told him that he had *accurately* examined these waters, and he said it was no such thing, and moreover, that a very small portion of salt was present."

In answer to Dr. Clark and Mr. Homersham, I prepared a paper, "On the Infiltration of Sea Water to the Wells under London and Liverpool." This paper was discussed for two evenings at the Institution of Civil Engineers, and for which I was honoured with a Council Premium—"Brande's Manual of Chemistry."

At the discussion, Mr. Dugald Campbell and Mr. Homersham were present, and took part.

On the second evening I produced the printed report, by Mr. Homersham, addressed to the Directors of the London (Watford) Spring Water Company, dated January 8th, 1850, *five years* prior to that gentleman's paper to the Society of Arts.

In that report I had found, in Appendix 1, page 43 to 46, a letter addressed to Mr. Homersham by Dr. Clark, of Marischal College, December 26th, 1849. I placed the report in the hands of Mr. Homersham, with a request that he would read to the meeting that part of the letter bearing on the chemical condition of the well water of Trafalgar-square. He did so as follows:—Page 45, line 16, "I say that the saline matter in the Watford spring water is of the same kind as the river water contains, meaning that it is of a very different kind from what is found in the deep spring waters below the London clay, commonly (however erroneously) called Artesian well waters, respecting which, as the only considerable source of supply of another quality of water within reach of London, I will take a brief notice.

"In the deep spring waters alluded to, there is a large quantity of *bicarbonate of soda*, 28¼ grains per gallon, according to the recent analysis in the Royal College of Chemistry, upon the water at Trafalgar-square.

"There are other 51.3 grains of saline matter present, say 79½ grains in a gallon in all. When boiled, this bicarbonate of soda is reduced to the carbonate of soda, and its alkaline taste may then be easily recognised in the water. A solution of carbonate or bicarbonate of water of this strength will act medicinally on the kidneys.

"By calculation from the analysis alluded to the hardness of the Artesian water is 5.9 grains, which nearly agrees with *my own experiments in this* and other deep waters in London; 100 gallons of *it* would form a lather with 13oz. of curd soap."

(Signed) "THOMAS CLARK."

I introduced this letter to show that Dr. Clark's friend could not have accurately examined this water, and that the Doctor must have forgotten what he had written in 1849, when he spoke on the subject at the Society of Arts in January 1855.

In the table I submitted, under the head Campbell and Clark, the accidental omission of a bracket has led to the erroneous impression that I attributed the other 51.3 grains of saline salts mentioned in Dr. Clark's letter to the sulphate of magnesia; a glance at the table will show the figure 51.3 midway, and it is only necessary to introduce the bracket to the printed table and the omission will be remedied; however, I apologise for the accident, the more so as it seems to have put Mr. Campbell sadly out of the way.

It only remains for me to explain the analysis of the College of Chemistry, which I have shown in the table to contain 67.2798 grains to the gallon of the Trafalgar-square well water. I find I have omitted ammonia apocrenic acid, and I think some other traces, but, to be hypercritically correct, I ought to have stated the solid contents at 69.9449228 to the gallon.

With your permission I shall resume this communication to you in your next number, but before closing this, I trust I have thus far temperately, but satisfactorily, disproved Mr. Dugald Campbell's assertion that nearly all the examples I adduced had been subjected to mutilation or change, his own among the number, and that in stating the solid contents in one gallon of Trafalgar-square so-called chalk water to be—

By Mr. Brande	66.1 grains to the gallon.	
By Dr. Clark	79.8	do.
By Mr. D. Campbell	58.85	do.
By College of Chemistry...	69.9449228	do.

I have ample authority for so doing.

I remain, sir, your very obedient servant.

FREDERICK BRAITHWAITE.

32, Gower-street, Bedford-square, May 26, 1856.

TRAFALGAR SQUARE WATER.

Sir,—In page 435 of your *Journal*, Mr. Frederick Braithwaite gives, as the result of *Dr. Clark's* analysis of a gallon of the Trafalgar-square water,

Bicarbonate of Soda...............	28.5 grains
Sulphate of Magnesia	51.3 „
Total...............	79.8 grains

The only authority Mr. Frederick Braithwaite can have for the above statement of his is the following passage in a report of Dr. Clark's to me, dated Marischal College, Dec. 26, 1849, on the subject of the Watford spring-water in reference to his softening process, and published by me at the time in an appendix to a Report to the London (Watford) Spring-water Company:—

"In the deep spring-waters alluded to, there is a large quantity of bicarbonate of soda; 28⅓ grains per gallon, *according to the recent analysis in the Royal College of Chemistry, upon the water at Trafalgar-square.* There are also *other* 51.3 *grains of saline matter* present; say 79½ grains per gallon in all."

You will observe that Dr. Clark does not here profess to give the results of an analysis of his own, but merely the results of simple calculations made by him from a then recent analysis that had been made in the Royal College of Chemistry. You will observe, too, that what Dr. Clark gives as 51.3 grains of *other saline matter* than bicarbonate of soda, Mr. Braithwaite tabulates as *sulphate of magnesia.*

The quantitative result as to carbonate of soda in the Royal College of Chemistry is given as 18 grains of carbonate of soda per gallon, according to the usual practice of chemists, although the soda is, in the water, really in the state of bicarbonate of soda, the well-known crystals, which would weigh 28⅓ grains, as Dr. Clark states. In short, Dr. Clark merely makes a few very simple calculations from the results of the analysis of the Royal College of Chemistry; yet, knowing this perfectly, Mr. Braithwaite, as if there had been a really different experimental result, signalises, among others, the names of Dr. Clark and the Royal College of Chemistry as chemical authorities, "*in each of whose analyses there was a very wide difference as to the chemical composition of the water.* It is therefore, (continues he) only fair to ask for some explanation on this subject."

Mr. Frederick Braithwaite's representations have made this explanation necessary to your readers, however superfluous it must be to himself.

I may mention, that the softened Watford water would be only half the hardness of the Trafalgar-square water, and would contain only an eighth of its saline contents.

I am, yours obediently,
SAMUEL COLLETT HOMERSHAM.

19, Buckingham-street, Adelphi,
May 28th, 1856.

P.S.—Dr. Clark, in his report to me of the 26 Dec., 1849, before alluded to, states that he had himself experimented on the "hardness" of the "Artesian" and other deep waters in London, but no where states that he had analyzed it.

THE OIL OF THE AVOCADO PEAR TREE.

Department of Science and Art, 8th May, 1856.

Sir,—I am directed by the Lords of the Committee of Privy Council for Trade to enclose for the information of your Society a copy of a letter from the Governor of Trinidad, in regard to the useful application of the oleaginous fruit of the Avocado pear-tree (*Laurus Persea*), and I am to request that you would kindly take such steps as you may deem desirable to bring it under the attention of manufacturers interested in the employment of fatty bodies.

I have the honour to be, Sir, your obedient servant,
LYON PLAYFAIR.

The Secretary, Society of Arts.

(Copy.)

Trinidad, 22nd February, 1856.

Sir,—In my long tropical service it had been a frequent source of surprise to me that no attempt had been made, at least to my knowledge, to ascertain whether the highly oleaginous fruit of the Avocado pear tree (the *Laurus Persea*) would not produce an oil suitable for culinary or illumination purposes, or for any of the other im portant uses to which vegetable oils are subservient, as the manufacture of soap, the lubrication of machinery, &c., &c. Shortly after my arrival here, pursuing this idea, I requested Mr. Herman Cruger, a German gentleman, of great intelligence, following the business of a chemist and druggist, in Port of Spain, to extract the oil from 100lbs. of the pulp of this fruit, and to experimentalise, with such conveniences as he had at hand, on its constituents and probable uses.

The results of Mr. Cruger's well conducted investigations, seemed to me to be so interesting, both on the material point of the proportion of oil to the bulk of pulp, and its excellent properties as an illuminant, that I deemed it right to transmit a few bottles, accompanied by his careful report, to Dr. Hofmann, Professor of the Royal College of Chemistry in London, who, I believe, stands at the head of his profession in the chemistry of vegetable substances.

By the last mail from England, the Professor had the goodness to forward to me the accompanying report, with specimens of the oleine, stearine, and soap which he had succeeded in producing from the Avocado pear oil I had sent to him. You will perceive with satisfaction that Professor Hofmann considers that this oil will prove to be a valuable addition to the oils used for illumination and in the manufacture of soap. He estimates the Avocado pear oil to be little inferior to sperm as an illuminant, and equal to palm oil for soap. I may mention on this last subject that the Indian women on the Main are said to use the fruit in the raw state with remarkable effect in the cleansing and strengthening of the hair, and the small specimens of soap produced from this oil, sent out by Professor Hofmann, strengthens my own impression that it will be found to have peculiarly softening effects on the skin. It will be noticed that the Professor does not consider it well settled yet, that the oil may not be purged of a certain acridity of taste (to which I incline to ascribe its detergent and softening effect on the skin and hair), but if that should prove practicable on experiments on larger quantities than he has hitherto treated, he thinks it might be extensively used for the same purposes as olive oil.

I have referred Professor Hofmann's Report to a Committee of our corresponding Society of Arts and Sciences, with the view to make it public in the Colony, and to collect detailed information from experienced persons respecting the best management of the tree, average weight of produce, &c. For the present, therefore, I shall merely say, that the "Laurus Persea" exists in large quantities in the Island, and that vast amounts of fruit are utterly wasted every year in the more remote districts. It bears fruit during about three months of the year, may be grown in any soil in these climates in protected situations from high winds (infrequent at Trinidad), needs no sort of cultivation, begins to bear at four or five years' growth, and produces as the tree becomes mature a prodigious weight of fruit. It should also be mentioned that some qualities are more oleaginous than others. The per centage of oil, according to Mr. Cruger's experiments, with imperfect means of expression, was between 12 and 13 per cent. to bulk of pulp, which, I believe, is heavier than the olive. I was informed by Mr. Purdie, the superintendent of our Botanical Garden, that 200 full-grown trees would be about the proportion—per acre, in systematically laid out plantations. I regret that I did not send some of the stones of the fruit to Professor Hofmann, for it produces a deep and indelible black stain, and might turn out to be useful in the manufacture of ink, and perhaps for other purposes.

I caused this oil to be exhibited at our annual exhibition of 1855, and the Committee of Management were pleased to award me a gold medal, but I requested them to present it to Mr. Cruger, who had, with much care and skill, established the usefulness of what was no more than a conception on my part.

May I hope you will authorise me to convey to this modest and truly useful member of this community, your approbation of the public spirited readiness he has always displayed in seconding efforts for ascertaining and developing the various and too neglected resources of this remarkable island. Such dispositions are well worthy of encouragement here and throughout the West Indies.

I have, &c.,
(Signed) CHARLES ELLIOT.

(COPY.)

Corresponding Committee of the Society of Arts,
Government House, 15th February, 1856.

The accompanying letter to his Excellency the Governor, and preliminary report on the application of the oil of the Avocado pear, by Dr. Hofmann, Professor of the Royal College of Chemistry of London, are published for general information.

It may be necessary to state that the authority of Professor Hofmann on all questions of the chemistry of oleaginous or fatty substances, is second to none in England, or probably in Europe.

The wardens of the several unions or parties interested in the cocoa cultivation of the Colony, are requested to forward any information which they may procure connected with the produce of the Avocado pear tree, or with the matters treated of in Professor Hofmann's report to A. W. Anderson, H. Cruger, and William Purdie, Esquires, a Committee of the Corresponding Committee of the Society of Arts.

By order of the Corresponding Committee
of the Society of Arts,
(Signed) SYL. DEVENISH,
Secretary, *pro tem.*

(COPY.)

Royal College of Chemistry, January 4, 1856.

SIR,—In reply to your letter dated 6th January, 1855, and which I received about a month later, I beg to forward you a preliminary report upon the oil which you submitted to me for examination, together with some specimens which were obtained from the oil in question.

This oil I received at about the same time, together with the lucid remarks of Mr. Herman Cruger, who extracted the oil from the Avocado pear.

I have to apologise for sending this report so late, but many previous engagements, and especially my co-operation as Juror at the Exhibition in Paris, which kept me away from London during a considerable part of the summer, prevented me from directing my attention to this examination at an earlier period. I hope, however, that the satisfactory nature of this preliminary report will, in some measure, compensate for the delay.

I have, &c.,
(Signed) A. W. HOFMANN.
His Excellency Governor Elliot.

(COPY.)

PRELIMINARY REPORT ON THE APPLICATION OF THE OIL OF THE AVOCADO PEAR.

The oil, when arriving in this country exhibited a dark greenish brown colour, it was rather viscid, and small particles of a solid fat were disseminated through the liquid. It exhibited to a remarkable degree the peculiar acrid taste which is mentioned in the statement accompanying the specimen.

The chief questions to which my attention was directed were the following:—

1. How can the oil be divested of its bitter taste, so that it might be used as an article of food.
2. What is the value of the oil for illuminating purposes, and can the solid fat be extracted with advantage.
3. What is its value as a lubricating material.
4. Is the oil applicable for the manufacture of soap.

With regard to the first point, I may state at once, that all my attempts to purify the oil from the acrid principle which renders its taste bitter and unpleasant have failed. The several specimens of the solid and liquid portions of the oil which I have prepared, all retain more or less this unpleasant bitterness, nor do I at this moment know exactly the substance which produces this disagreeable flavour. But, although the experiments hitherto tried have not been successful, it is by no means impossible that a further prosecution of this inquiry may lead to very different results, especially if a more copious supply of the material should enable us to operate upon a larger scale. When separated from the acrid source of this taste and from a small amount of mucilaginous matter, (the elimination of which presents no difficulty) this oil might be used as a substitute for olive oil in the preparation of food.

In testing the applicability of the oil for the purposes mentioned under the second head, the results obtained were more satisfactory. In fact when submitted to a very simple process of purification somewhat similar to that which is used in France for the refinement of rape oil, (and which essentially consists in treating the oil with a small quantity of sulphuric acid for the purpose of destroying the mucilaginous principles) this oil becomes a substance extremely valuable as an illuminating material. It may be used for burning in lamps with considerable advantage; in fact, the illuminating power of the oil is not very much inferior to that of the average quality of sperm oil. I believe that burning in lamps will be one of the principal applications which the oil will receive, when it is prepared on a more extensive scale, and delivered in a larger quantity in the markets. I may state that several practical men to whom I have shown the oil in the crude and in the refined condition, concur with me in this opinion. My friend Mr. George Wilson, the managing director of that colossal establishment, "Price's Patent Candle Company," who, from his particular experience and from his numerous researches and investigations connected with the manufacture of fatty bodies, must be considered as one of the best authorities upon this subject; Mr. George Wilson, who has kindly assisted me in these experiments, after having become acquainted with the oil, immediately offered to take fifty tons, or any fraction of fifty tons of the oil, at the price of £30 per ton, delivered in London, for the purpose of carrying out the inquiry suggested by your Excellency on a scale commensurate with the importance of the subject.

I have also endeavoured to separate the solid fat, the stearine from the oil of the Avocado pear, as far as this is possible by processes which are applicable upon a large scale. The amount of solid fat is far inferior to that which I was led to expect at the first glance, the viscidity of the original oil being greatly due to the presence of mucilaginous matters. I have the honour of transmitting, together with this report, specimens of the liquid and of the solid portions of the oil. Your Excellency will remark that, though these specimens are not absolutely colourless, their colour has been greatly diminished by the simple process of refining with sulphuric acid.

According to my present experience, the oil of the Avocado pear is less valuable as a lubricating material. To make it fit for the higher classes of machinery, its mucilaginous constituents must be removed by the same refining process requisite for its adaptation in illuminating purposes. This will slightly increase its price. Even when purified it retains an attraction for oxygen, by which it becomes rapidly coloured, viscid, and actually acid. It cannot, either in price or in applicability, compete with that remarkable substance "Paraffin Oil," which has

been discovered within the last year by Mr. James Young, and which is now manufactured by him on a large scale, by the distillation at a low temperature of several varieties of coal.

On the other hand, the oil of the Avocado pear is very well applicable for the production of good soap. I have the honour of transmitting to your Excellency specimens prepared with the oil; the smaller one, which possesses a yellow colour, is prepared with the oil in its original condition; the larger one is made with a portion of oil which had previously been bleached by chlorine. From this specimen it is obvious that the oil, although poor in stearine, nevertheless, furnishes a soap which is tolerably hard and solid. It ought to be remembered that it is difficult to obtain a hard soap by working on the small scale prescribed by the limited amount of material at my disposal. For the more perfect elaboration of this investigation also, a large supply of material will be of great advantage; but I have even now no hesitation in stating, that for the purposes of the soapmaker, the oil of the Avocado pear will have at least the same value as palm oil.

From the above statements your Excellency will perceive that the oil of the Avocado pear is a substance of considerable commercial value; that it is very probable that this value will be greatly increased if the command of a larger quantity should enable practical men to carry out experiments on a larger scale, and one far more likely to procure the oil in a state of greater purity than could be accomplished by small laboratory trials.

I would, therefore, suggest that your Excellency should direct that measures be immediately taken for producing and transmitting to this country a larger supply of oil. The experience and the manipulatory dexterity of Mr. H. Cruger will, no doubt, afford great assistance in effecting this object.

The oil of the Avocado pear can be obtained with great facility. The applications of which it is capable are valuable and numerous. The substitution of the *Laurus Persea* for the useless *Erythrina Umbrosa*, under the shadow of which the cocoa tree is now growing, must be highly advantageous to the cultivation of that useful plant.

All these things being considered, the idea of promoting the growth of the *Persea* appears to me a most happy conception, and when carried out with vigour and circumspection cannot fail to confer lasting benefits on the Colony.

I have, &c.,

(Signed) A. W. HOFMANN, F.R.S.

Proceedings of Institutions.

Annan.—The eighth annual report states that the number of life members is now 19; that of honorary members has averaged during the year, 30; ordinary, 139; lady, 10; and apprentices, 18. These, compared with last year's returns, show a small decrease in honorary and apprentice members, an increase of life members, and about an equal number of ordinary and lady members. It states that the library now contains upwards of 1,400 volumes, and that there is a prospect of its being considerably augmented in a short time. It has been increased during the current year by about 150 volumes, all of which, with the exception of 21 volumes of a Statistical Account of Scotland, presented by Mr. C. Dall, factory-manager, Annan, and about ten volumes presented by friends, have been purchased with the funds of the Institute. The issue of books was about 200 volumes weekly during the winter quarters. The news-room in the Town-hall continues to be supplied with upwards of 30 of the leading metropolitan, provincial, and local newspapers, and *Blackwood* and *Tait's Magazines*. During the winter twelve lectures were delivered in connection with the Institute, and an entertainment was given by Mr. Hart, of Ulverstone, to a large audience, the proceeds of which, amounting to £8 17s., were presented to the Institute. During part of the year a Literary and Discussion Class was kept up with spirit. A variety of articles of curiosity have been added to the Museum.

Dawlish.—The sixth annual *soirée* of the Literary Society was held at the Assembly-rooms, on Thursday, the 7th ult. Tea was provided at seven o'clock, of which about 100 of the members and their friends partook. After tea, C. J. Plumptre, Esq., barrister-at-law, President of the Society, delivered an address, in which, referring to the title of the Society, he said—in an agricultural parish like Dawlish it would have been a misnomer to have called it a Mechanics' Institute; and they could not have been expected, for one moment, to compete with the great Mechanics' Institutes of Liverpool, Manchester, and other large manufacturing towns. He did not think that such Societies as that whose anniversary they were met to celebrate could be considered as educational *substitutes* in any way; but he believed they could be made the means of affording, by useful and entertaining lectures, much valuable information to those whose time and toil prevent them devoting the time that they could wish to literary pursuits; that they might be made the vehicles for presenting many materials for thought and subsequent reflection; the common meeting-ground of various classes, and the mart for exchanging kindly feelings and mutual sympathies; and also the means of affording innocent and agreeable relaxation—a stimulus to higher and purer sources of pleasure than those afforded by low and sensual gratifications, and an introduction to a wide and boundless field of enjoyment. Mr. D. Babbington Rind and Mr. P. J. Margary having addressed the meeting, a concert of vocal and instrumental music followed, the proceedings terminating with a ball.

Huddersfield.—The announcement of the prizes for 1856, in connection with the Mechanics' Institute, has just been made. It is an important one, embracing the distribution of Prince Albert's present of twenty-five guineas, and a donation of six pounds from the Dean of Hereford. The first prize is one of three guineas for an original design, a second prize of two guineas being also given. Two guineas will be awarded for the best original essay, with a second, of one guinea, for the next in excellence. The rest of the sum given by the Prince is divided into guinea and half-guinea prizes, for the twenty-eight advanced classes, which are grouped to facilitate the division, or as first prizes for some of the more numerous of the forty-eight elementary classes. Subordinate prizes, of less value, will also be given in the junior sections. The Dean's gift is, at his request, to be awarded in three prizes, for the best examinations in the respective studies of geometry, physical geography, and English history from the accession of Henry VII. to that of Charles I. The prize programme also contains a valuable award in the nomination to a situation in the civil service, offered, as an annual prize, by Mr. John Wood, the Chairman of the Board of Inland Revenue, through the kind intervention of the Dean of Hereford.

Royston.—The exhibition in connection with the Mechanics' Institute has now been closed. It was opened twenty-two times during the fortnight, and was visited by nearly 6,940 persons. The average number present on each day was 578, and the greatest number present on a single day was 1,657. It was opened twice specially for mechanics and domestic servants, and twice for National, British, and Sunday Schools. The proceeds amounted to £327 14s. 8d. up to the close of the Exhibition, since which time there have been further receipts, and there is a prospect of additional funds arising from the sale of articles presented to the Institute, and at present remaining unsold. A large sum will, of course, have to be deducted from this amount for the expenses of the Exhibition; but there will remain a handsome balance in liquidation of the building debt. On Wednesday evening, the 28th instant, a promenade concert was given in the Lec-

ture-hall. The principal feature of the evening was the presentation of a testimonal clock to the Honorary Secretary, Mr. John Warren. On its face was inscribed:—"Presented by the Members of the Royston Institute to John Warren, to mark their sense of his able and zealous services as Honorary Secretary, May 12, 1856."

Miscellanea.

Decimal Coinage.—The state of the Decimal Coinage question is now as follows:—After the strong recommendation of one particular plan by two scientific Commissioners, by a Committee of the House of Commons, and by a vote of the House itself, followed by the organisation of an association containing hundreds of parliamentary and hundreds of commercial names, and supported by the Bank of England,—Lord Palmerston appointed a Royal Commission, consisting of Lord Monteagle, Lord Overstone, and Mr. Hubbard, to consider the whole question. This Commission has now been at work some months; but none of its proceedings have been published. The plan so strongly supported is, as our readers know, that the present pound should be retained, but made to consist of 1,000 new farthings, or *mils.*, instead of 196 of the present farthings. This plan retains the florin (100 mils), the shilling (50 mils), the half shilling (25 mils). It also retains the copper coins, lowering their value 4 per cent., so that the *sixpence* (as it will still probably be called) is 25 mils instead of 24 farthings. A new coin of 10 mils, the *cent*, very like 2½d. of the present money, completes the system. It is strongly contended that no change so simple as this is to be found among all the schemes which have been proposed. On the other hand, a strenuous few, but with very little support, have contended for systems which throw out the sovereign and the shilling, building up from the penny in one proposal, from the farthing in another. Surely it would be easier to keep the existing pound, the existing florin, shilling, and half-shilling all unaltered, and the minor coins at 4 per cent. less value, than to learn a new system in which the coins are ½d., 2½d., 2s. 1., and £1 10d.; or else one in which the new coins are $\frac{1}{10}$d., 1d., 10d., and 8s. 4d. of our present money. The genius of English reform is to alter as little as possible, and to keep as much of the old way as possible. A re-fabrication of all the silver *coinage* is a thing which will never be done, except under the most urgent necessity. The shillings in circulation, piled one upon another, would make a *rouleau* eighty miles high. The most prominent advocates of the farthing and penny schemes recognise the difficulty of recoinage, and propose that the new coins shall be gradually introduced, and the old ones gradually withdrawn. Thus, for a long period, we should have two different systems of payment, under what is presumed would be one system of reckoning, the new decimal system.—*Athenæum.*

PARLIAMENTARY REPORTS.

SESSIONAL PRINTED PAPERS.

Delivered on 24th and 26th May, 1856.

Par. No.
137. Bills—Poor Law Amendment (Scotland).
138. Bills—Sir William Fenwick Williams' Annuity.
139. Bills—Annuities (No. 2).
140. Bills—Reformatory and Industrial Schools (as amended in Committee, and on Re-commitment).
141. Bills—Public Health Supplemental Bill.
144. Bills—Oath of Abjuration (Amended).
147. Bills—Grand Jury Assessments (Ireland) (Amended).
148. Bills—West India Loans (Amended).
Poor Law Board—8th Annual Report.
Loan Fund Board of Ireland—18th Report.
Census of Ireland for the year 1851—Part 5 (Tables of Deaths), Vol. 2.

Delivered on 27th May, 1856.

39 (4) Trade and Navigation Accounts (30th April, 1856).
231. Public Health Act—Return.
232. River Weaver (Account).
142. Bills—Small Debts Imprisonment Act Amendment (Scotland).
149. Bills—Lunatic Asylums (Ireland) (No. 2).

Delivered on 28th and 30th May, 1856.

177. Charities—Return.
232. Suspended Canonries—Return.
41. Local Acts (29, Isle of Wight Steam Bridge and Approaches (Supplementary Report); 30, Sittingbourne and Sheerness Railway)—Admiralty Reports.
134. (1) Sherburn Hospital—Copy of a Letter.
208. Factories—Returns.
222. Public House Licenses—Returns.
234. Sligo Election—Minutes of Evidence.
236. Spirits (Ireland)—Returns.
237. Metropolis Roads—Return.
240. Insolvent Debtors' and Bankruptcy Courts (Ireland)—Return.
243. Coalwhippers (Port of London)—Returns.
174. Ecclesiastical Commission—Appendix to First Report.
107. Bills—Dublin Metropolitan Police.
135. Bills—Judges and Chancellors.
145. Bills—Police (Counties and Boroughs) (as amended in Committee, on Re-commitment, and on Consideration of Bill, as amended).
153. Bills—Reformatory and Industrial Schools (as amended in Committee, on Re-commitment, and on Second Re-commitment.
154. Bills—Public Health Act Amendment.
155. Bills—Burial Acts Amendment.
152. Bills—Joint Stock Companies (as amended in Committee, on Re-commitment, and on Second Re-commitment).
151. Bills—Gaols, &c.
150. Bills—Dublin University.
Emigration—16th Report of the Commissioners.
Inspectors of Factories—Reports (30th April, 1856).

Delivered on 31st May and 2nd June, 1856.

199. Superannuations—Return.
209. Sugar, &c.—Return.
221. (1) Public Libraries (Ennis, Cork, and Limerick)—Return.
241. Plumstead Parish (Want of Accommodation for Divine Worship)—Copy of Memorial.
216. Statute Law Commission—Return.
230. Church Affairs (Jamaica)—Copies of Correspondence.
143. Bills—Nuisances Removal, &c. (Scotland) (No. 2.)
156. Bills—Smoke Nuisance Abatement (Metropolis) Act, 1853, Amendment.
157. Bills—Excise.

Delivered on 3rd June, 1856.

246. Preston Union (Lancaster)—Correspondence, &c.
146. Bill—Poor Law Amendment (No. 2).
Charitable Donations and Bequests (Ireland)—11th Annual Report.

Delivered on 4th June, 1856.

90 (7). Civil Services Estimates—Class 7 (a corrected leaf).
239. King's College, Aberdeen—Return.
158. Bill—Registration of Voters (Scotland) (as amended by the Select Committee.)

MEETINGS FOR THE ENSUING WEEK.

Mon. Geographical, 8½, 1. Renewed discussion on Capt. Stokes' paper "On Steam Communication with Australia and the Cape of Good Hope." 2. "Mr. Lionel Gisborne, "Isthmus of Darien—Investigations connected with the Search for the Best Locality to make an Inter-Oceanic Canal." 3. Admiral Illingworth, "Note on the Isthmus of Cupica." 4. Mr. W. D. Cooley, "Journey of Joachim Rodriguez Graça to the Muata ya Nu, Central Africa."

Tues. Royal Inst., 3, Mr. T. A. Malone, "On Photography."
Syro-Egyptian, 7½, Mr. Mackenzie, "On the Inscriptions on the Temple of Edfou, and the Egyptian Names of Planets."
Medical and Chirurgical, 8½.
Zoological, 9.

Wed. Literary Fund, 3.
Royal Society, Literature, 4½.
Society of Arts, 8, *Extra*, Mr. Humphrey Chamberlain, "The Drying and Burning of Bricks."
Ethnological, 8½.

Thurs. Royal Inst., 3, Prof. Tyndall, "On Light."
Antiquaries, 8.
Royal, 8½.

Fri. Astronomical, 8.
Philological, 8.
Royal Inst., 8½, Prof. Faraday, "On some Points in the Molecular Philosophy of Gold and Silver; M. Petitjean's Silvering Process."

Sat. Royal Inst., 3, "Dr. A. W. Hofmann, "On the Non-Metallic Elements, their Manufacture and Application."
Royal Botanic, 3¾.

PATENT LAW AMENDMENT ACT, 1852.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette May 30th*, 1856.]

Dated 7th April, 1856.

836. John Gedge, 4, Wellington-street South, Strand—Improvements in tiles for buildings. (A communication.)

Dated 6th May, 1856.

1062. Obed Blake, Thames Plate Glass Works, Blackwall—Improvements in applying practically the principle of internal reflection within transparent substances.
1064. William Joseph Curtis, 1, Sebbon street, Islington—Improvements in constructing the permanent ways of railways.
1066. William Edward Newton, 66, Chancery-lane—Improved machinery for making envelopes. (A communication.)
1068. Richard Archibald Brooman, 166, Fleet-street—A method of treating guano and other matters containing uric acid and the manufacture from the products arising from such treatment as well as from uric acid, of new colouring matters, and the fixing and application thereof. (A communication.)

Dated 13th May, 1856.

1122. Michael Hodge Simpson, Massachusetts, U.S.—Improvements in machinery for combing wool or various other fibrous substances.
1124. Hiram Tucker, Massachusetts, U.S.—Improved spring sacking or foundation for a bed mattress, or other like article.
1126. Charles Boosey, 24, Holles-street, Cavendish-square—Improvements in music stands for the use of military and other bands. (A communication.)
1128. William Edward Newton, 66, Chancery-lane—Improved apparatus for generating illuminating gases from coal or other substances. (A communication.)
1130. William Edward Newton, 66, Chancery-lane—The novel application of certain substances to be employed in printing upon woven or other fabrics, and paper. (A communication.)

Dated 14th May, 1856.

1132. William Galloway and John Galloway, Manchester—Improvements in machinery for rasping, cutting, and chipping dye woods.
1134. Joseph Hadley Riddell, 5, Sherborne-lane, City—Improvements in stoves or fire places.
1136. Jerome André Drieu, Patricroft, near Manchester—Improvements in weaving horse cloths, blankets, rugs, or similar thick materials.
1138. Uriah Scott, Camden-town—Improvements in public carriages, and various parts of the same, which parts may be used separately, and applied to vehicles of any description.
1142. Charles Gibson, Draycott, Derby—Improved machinery for the manufacture of bricks, tiles, pipes, and other articles made of clay or plastic materials.
1144. William Horatio Harfield, 113, Fenchurch-street—Improvements in machinery for cutting and smoothing the surfaces of metallic nuts. (A communication.)

Dated 15th May, 1856.

1146. John Cox, Ivy-bridge-cottage, near Caerleon, Monmouthshire—Improvements in coke and coke ovens.
1147. Robert Walker and Alexander McKenzie, Glasgow—Improvements in electric telegraphs.
1148. William Norris and Robert King, Liverpool—Improvements in anchors.
1150. James Leck and Alexander Miller, Glasgow—Improvements in singeing textile fabrics.
1152. Hugh Greaves, New Palace-yard—Improvements in the permanent way of railways.
1153. Charles Richard Williams, Shiffnal—Improved implement or apparatus for the cultivation of land.
1154. Richard Archibald Brooman, 166, Fleet-street—Improvement in stuffing seats, cushions, furniture, and other similar articles. (A communication.)
1155. Samuel Weston Moore, Nottingham—Improvements in dividing and finishing lace goods.
1156. William Marychurch and John Griffiths, Haverfordwest—Improvements in horse rakes, part of which is applicable to two-wheel carriages.
1157. Matthew Townsend, Leicester—Improvements in the manufacture of knitted fabrics.
1158. William Smith, 10, Salisbury-street, Adelphi—A new application of the syphon as an irrigator, and a motive power machine. (A communication.)

Dated 16th May, 1856.

1162. William Henderson, Dunkeld, Perthshire—Improvements in the manufacture of brooms.
1164. Andrew Barclay and John Wallace, Kilmarnock—Improvements in apparatus for the manufacture and measurement of illuminating gas.

Dated 17th May, 1856.

1166. Richard Coleman, Chelmsford—Improvements in implements for ploughing, hoeing, and scarifying land.
1168. Siegerich Christopher Kreeft, Fenchurch-street—Improvements in the manufacture of iron and steel. (A communication.)
1170. Gustav Sheurmann, 86, Newgate-street—Improvements in printing music.
1172. Johan Jacob Meyer, 28, Tatham-street, Molesworth-street, Rochdale—Improvements in machinery for mortising, tenoning, rounding, sweep and straight moulding, boring, grooving, and mitreing.
1174. Charles Titterton, Roehampton—Improvements in the manufacture of zinc and zinc white.
1176. Richard McCloy and John Hare, Glasgow—Improvements in spinning and twisting fibrous materials, and in the machinery or apparatus employed therein.
1178. George Carter, Mottingham, Kent—Improvements in the mode of propelling and steering vessels, and in the apparatus and machinery applicable thereto.

Dated 19th May, 1856.

1180. Jeremiah Brown, Kingswinford—Improved machinery to be used in the manufacture of iron.
1182. George Clark, Great Cambridge-street, Hackney-road—Improvements in the manufacture of illuminating gas.
1184. John Kinnersley Smythies, 27, Kensington-park-gardens—Improvements in apparatus or instruments for ascertaining the points of the compass, and the latitude and longitude of a place.

WEEKLY LIST OF PATENTS SEALED.

Sealed May 30th, 1856.

2730. John Marsh.
2731. Adam Bullough.
2740. Alfred Vincent Newton.
2742. Charles Hawker and Thomas Parry Hawker.
2744. William Mosley.
2766. John Allin Williams.
2786. Richard Archibald Brooman.
2811. Richard Holben.
2857. William Wilkinson.
2888. Jean Baptiste Emile Saffroy.
2805. Edward Tyer.
108. Joseph Hostage, Thomas Ives Brayne Hostage, and John Tatlock.
342. Charles Swan and George Frederick Swan.
558. Charles Morgan and Chas. Ranken Vickerman.
628. Joseph Dumas.
666. John Watson Burton and George Pye.
706. John Henry Johnson.
708. George Hallen Cottam and Henry Richard Cottam.
709. James Hargraves.
726. William Edward Newton.
751. Alfred Vincent Newton.
799. Henry George Hine.

Sealed June 3rd, 1856.

2732. John Moffat.
2733. William George Plunkett and John Bower.
2734. William Nunn.
2735. Thomas Mara Fell.
2737. Caesar Heilmann.
9754. Thomas Russell Crampton.
2755. Angier March Perkins.
2757. Angier March Perkins.
2762. James Gardner, Henry Gardner, and John Carey Gardner.
2764. Charles Lenny.
2768. Henry Bessemer.
2778. Andrew Maclure.
2782. Thomas Heppleston and John Hunter.
2794. Alexandre Tolhausen.
2804. Rogers Ruding.
2805. Robert W. Davis and Daniel Davis.
2810. William Leighton.
2859. Alexandre Tolhausen.
2876. Robert Walker.
2896. Henry Francis.
2898. William Joseph Curtis.
2902. John Henry Johnson.
2904. Christopher Dresser.
2906. Edward Rowcliffe.
2918. Alexandre Tolhausen.

PATENTS ON WHICH THE THIRD YEAR'S STAMP DUTY HAS BEEN PAID.

May 26th.

1310. William Henry Bentley.
1321. Edward Duclos de Boussois.
1662. Abraham Walter Craig, Daniel Foster, and Thomas Valentine.

May 27th.

1318. Daniel Bateman.

May 28th.

1347. Admiral the Earl of Dundonald.
1351. John Robert Johnson.
1360. William Edward Newton.
1369. James Hayes.
1420. Samuel Frankham.

May 30th.

1340. Edward Wilkins.

WEEKLY LIST OF DESIGNS FOR ARTICLES OF UTILITY REGISTERED.

No. in the Register.	Date of Registration.	Title.	Proprietors' Name.	Address.
3837	May 15.	The New Union or Alliance Buckle	William Aston..................	Birmingham.
3838	May 16.	Improved Spring-Fastening for securing the covers of small fancy and other boxes used for holding small wares, such as buttons, pens, hooks and eyes, &c., such articles as are usually made up and sold in boxes ..	William Aston..................	Birmingham.
3839	May 19.	Improved Double or Single-Action Rotatory Carpenters' Brace Heads	W. Adsetts	Sheffield.
3840	May 21.	Dent's Perfected Collar	Dent, Allcroft, and Co.... ..	97, Wood-street, Cheapside.
3841	May 23.	The Derwas Curricle and Harness	Edwin Kesterton..............	Long-acre.
3842	May 26.	Improved Lever Cask Stand	Richard Waygood	Newington Causeway.
3843	May 26.	Improved Lock	Cope and Collinson	Birmingham.
3844	May 26.	Penholder	Joseph Gillott..................	Birmingham.